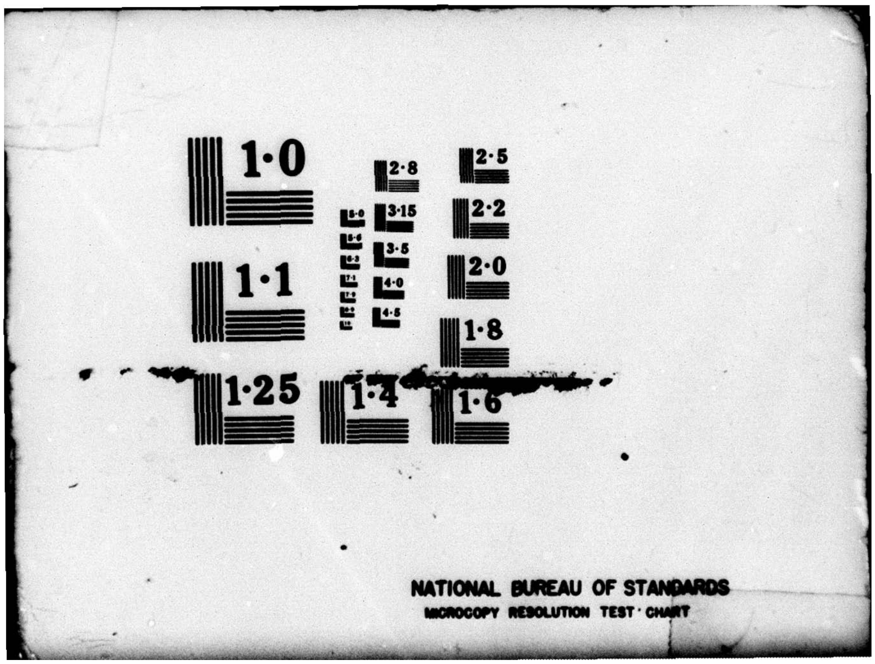
AD-A060 915 NAVAL SURFACE WEAPONS CENTER DAHLGREN LAB VA F/G 15/3
MODULAR WEAPON SYSTEM SIMULATION SOFTWARE DESIGN AND OPERATION --ETC(U)
SEP 78 W MCLAUGHLIN
UNCLASSIFIED NSWC/DL-TR-3874 NL

1 OF 1
ADA
060915

END
DATE
FILMED
1 79
DDC


1·0
1·1
1·25
1·4
1·6
1·8
2·0
2·2
2·5
2·8
3·15
3·5
4·0
4·5
NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 14 NSWC/DL-TR-3874	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 6 MODULAR WEAPON SYSTEM SIMULATION SOFTWARE DESIGN AND OPERATION REQUIREMENTS.		5. TYPE OF REPORT & PERIOD COVERED 9 Final rept.,
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) 10 Wayne/McLaughlin		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Surface Weapons Center Dahlgren Laboratory (K72) Dahlgren, Virginia 22448		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NIF
11. CONTROLLING OFFICE NAME AND ADDRESS		12. [redacted] 11 Sep[redacted]78
		13. [redacted] 58
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) 12 56p.		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

SIMULATION, MISSILE, WEAPON SYSTEM, SOFTWARE DESIGN, TRAJECTORY, MODULAR STRUCTURE, STRUCTURED PROGRAMMING

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A computer simulation which models a tactical surface-launched missile system has been operational as of August, 1978, on the CDC 6700 computer, under the SCOPE 3.4 operating system, at the Naval Surface Weapons Center, Dahlgren, Virginia.

The program uses a simplified three-degree-of-freedom trajectory representation, and is comprised of modular elements, whose actual break-

over

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

S/N 0102-014-6601

391 598

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

#20

down scheme is based on both independent functional operation and susceptibility to future change. The use of state-of-the-art structured programming techniques has enabled this design method to be effectively executed.

Additionally, a load time option resolution utility has been developed and implemented, which results in greater execution efficiency and improved utilization of computer memory resources. This feature has been interfaced with a general purpose input processor software package, resulting in simplified user input which can conveniently undergo slight alterations during a multiple flight run. The complete system is under the jurisdiction of an automated control card procedure facility, which controls execution of all portions of the model, and reduces the number of control cards which must be prepared by the user to a minimum.

This report provides instructions for operating the model and presents detailed descriptions of the entire software configuration and each of its components. References are made to existing documentation covering particular areas, in cases where such text is available.

FOREWORD

A missile system computer model which incorporates a simplified three degree of freedom trajectory representation has been produced by the Strategic Systems Department (K), as part of the development of a general purpose, surface-launched tactical weapon system simulation capability, which was undertaken during the fiscal year 1977.

The design and development of the necessary software was performed by Mr. Wayne E. McLaughlin of the Operation Sciences Branch of the Computer Programming Division (K-72). The specifications for the model, including its associated modular structure, were communicated to K-72 by Mr. Frank L. Stevens, Mr. Samuel R. Hardy, and Mr. John S. Weisel, of the Aeromechanics Branch of the Exterior Ballistics Division (K-21).

Released by:

Ralph A. Niemann

RALPH A. NIEMANN, Head
Strategic Systems Department

CONTENTS

CONTENTS

SECTION 1. INTRODUCTION

The development of a general purpose tactical surface-to-air missile system simulation capability at the Naval Surface Weapons Center, Dahlgren Laboratory, Dahlgren, Virginia, has been in progress during the last two years. One portion of this effort has been production of a model which encompasses the so-called 3-degree-of-freedom trajectory formulation. The requisite mathematical formulas for the 3DOF model were defined by the Aeroballistics Division of the Strategic Systems Department (K-21) and are documented in reference 1. The associated computer software has been developed for the CDC 6700 computing system at NSWC/DL, under the Scope 3.4 operating system, by the Operation Sciences Branch of the Computer Programming Division (K-72).

This report describes the functional operation of the various software routines involved, provides an in-depth look at their composition, and supplies instructions concerning model use. Where appropriate, references are made to existing documents which may be consulted when more detailed information is desired.

SECTION 2. SYSTEM DESIGN

2.1 Objectives. A generalized set of requirements to be fulfilled by the model were established early during the development phase:

1. Modularity. The model should be constructed in a modular manner, with the modules corresponding to functional portions of the simulation which seemed susceptible to future modification. These changes could involve modeling the same program element in greater detail, or using a slightly different approach to obtain the same quantity or quantities.

2. Execution efficiency. The program should use as little computer time and memory space as possible, during execution.

3. Simplified use. The input of data values should be accomplished in an expedient manner. The amount and complexity of control cards to be prepared by the user should be kept to a minimum.

2.2 Configuration.

2.2.1 Program Structure. State-of-the-art structured programming techniques were employed toward achieving the modularity requirement for the simulation. Of major importance are those discussed in sections 2.2.1.1 and 2.2.1.2.

2.2.1.1 Stepwise Refinement. Structured programming involves, among other things, the application of a process called "stepwise refinement", which consists of designing a program in a "top down" fashion. That is, a system is divided up into a relatively small number of generalized functional events which are executed in sequential order, called the "top" or "executive" level. Each of these independent "modules" is then broken up into another relatively small number of less general and independent routines, which comprise the "second" level of the development. Successive application of the technique to each level of the design produces the next lowest level, until the most detailed level desired is obtained.

This method of designing a program automatically imposes a modular structure on the result. Among the advantages gained by this technique is that the types of changes mentioned in section 2.1 can be accomplished more easily.

2.2.1.2 Program Design Language. Program design language (PDL) is an automated tool which, when used in conjunction with stepwise refinement, produces a formatted design document of a structured program. The design phase of the simulation chiefly consisted of the preparation of a PDL document (reference 2), which describes the flow of the simulation in detail. This was then used as a guide when the actual source code was written.

Instructions on how to prepare input to the PDL processor can be found in reference 3 (PDL reference guide). Execution of the processor as implemented at NSWC/DL is discussed in section 4 of this document.

2.2.2 Input Processor. All input quantities to the simulation are entered prior to the start of execution, by loading FORTRAN BLOCK DATA subprograms containing DATA specification statements (reference 4) which initialize each variable to its desired value. These subprograms are created just prior to execution by a general purpose input processor developed by the Ballistic Sciences Branch of the Computer Programming Division (K-71). This software package requires, a priori, an initialization file, which defines the input data scenario for the particular case being run, and a default file, which furnishes a default value for each input item. Consequently, the input actually submitted can be restricted only to variables for which it is desired to change the default value. Other features of the processor include free form input format and the capacity to make multiple runs using a dynamically maintained, cumulative default file.

Both data bases are generated prior to the simulation. The exact structure of each is detailed in reference 5, which also provides instructions on how to prepare input for the processor. The creation, interfaces, and maintenance of these data bases, as used by the simulation model, are described in subsequent sections of this document (2.2.4, 3.1, 4.2 and 4.3).

2.2.3 Load Time Option Resolution. The model was designed with a built-in capability for performing some functions in more than one way. Section 3.1.1 contains the list of these options and the choices available for each, as of model installation. Reference 1 contains the mathematical formulation for and descriptions of each option.

It was desired to have some method of resolving the options selected for the run at load time (prior to the start of execution), in order to avoid loading routines into memory which would never be executed. Additionally, faster execution speed would be achieved by the elimination of sections of code which would serve only to choose among different methods of performing a particular function, and would have to be executed prior to the invocation of the function, each and every time it is performed. This was accomplished through the use of the SUBST parameter on LDSET loader control cards (reference 6), appropriately inserted into the job control card sequence. This effectively enables one FORTRAN subroutine to be substituted for another during program execution, without having to load the unused subroutine into memory. This substitution is automatically made every place that a CALL to the pre-empted subroutine occurs in the program source code.

It was then of crucial importance that each version of a particular function be contained in its own subroutine sequence, but this is an almost natural consequence of the stepwise refinement design process (sect 2.2.1.1). Additionally, some effort was directed toward the identification of those program elements for which the option capability might be desired at some future time. The results are reflected in the ultimate program design.

2.2.4 Interfaces. Figure 1 illustrates the interfaces resulting from the assembly of the elements described in sections 2.2.2 and 2.2.3 into a complete system. The MSS option processor is a brief FORTRAN program which processes the input simulation option overrides (sect 2.2.3), and causes the creation of a corresponding initialization file for the input processor (sect 2.2.2) and a procedure of control cards for executing the program, with any required LDSETs inserted (sect 2.2.3). The input processor (INPUTP) then uses the initialization file, default file, and any default data overrides input to generate the required FORTRAN BLOCK DATAs, which are then compiled. The resultant object code is loaded into memory, along with the necessary simulation modules from the user library (MSSLIB), following which program execution is initiated, under the direction of the control card procedure.

The control card procedure itself is driven by the system BEGIN/REVERT utility (reference 8). This facility provides a means of executing a sequence of control cards contained on a local file by issuing a single directive (the BEGIN command). The simulation system itself is operated by another series of BEGIN/REVERT procedures, whose use is described in section 3 of this document, and whose configuration is described in section 4.

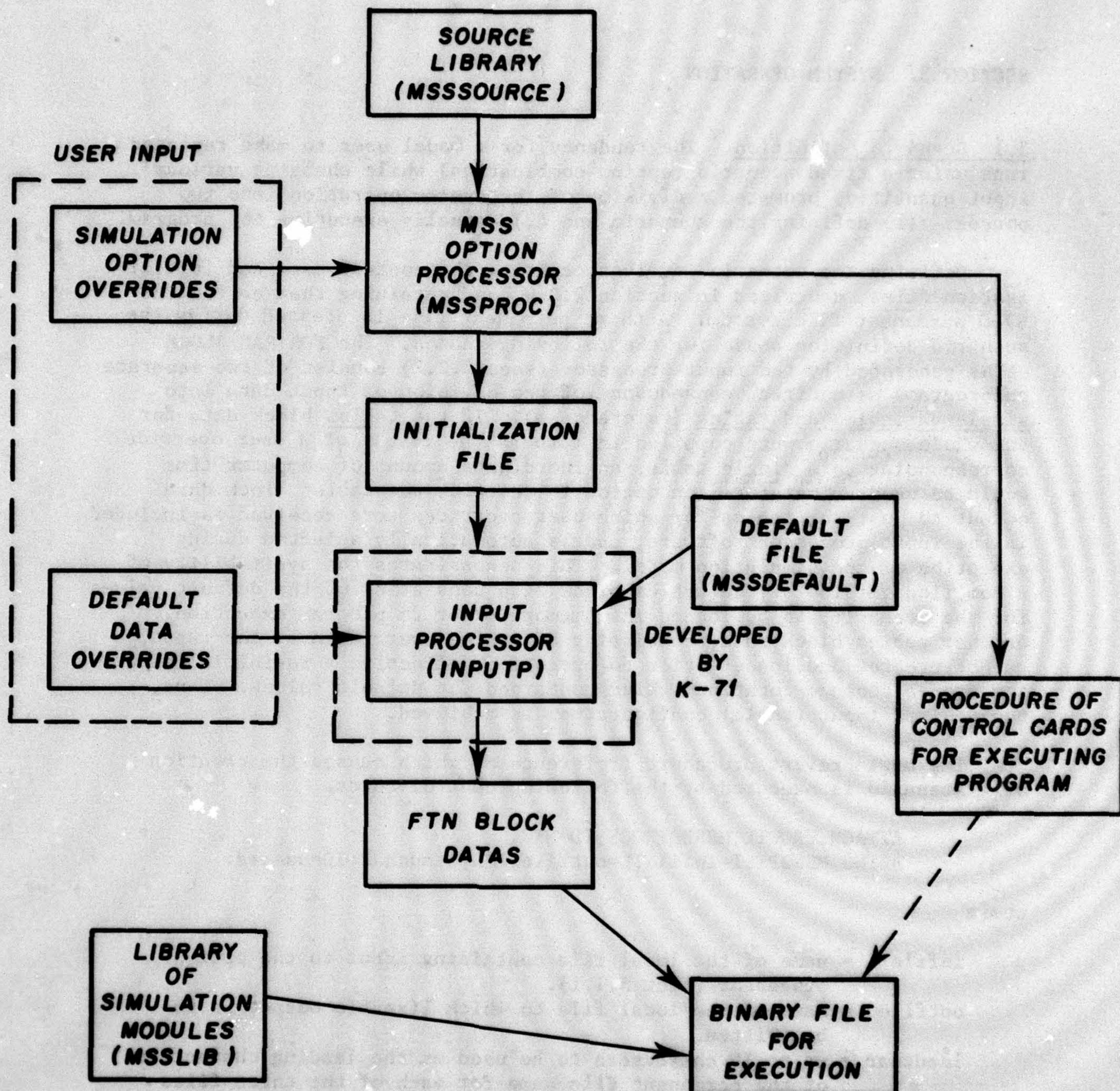


FIGURE 1. SYSTEM INTERFACES

SECTION 3. SYSTEM OPERATION

<u>3.1 Scenario Definition</u>. The tendency for a model user to make repeated runs using a fixed scenario (option combination) while changing various input quantities prompted a division of the system operation into two phases: (1) defining the scenario, and (2) actually executing the program.

Defining the scenario involves creating the control card and initialization files, described in section 2.2.4, and retaining them on the CDC 6700 permanent file system. A third permanent file is created during the scenario definition phase for the following reason. The FORTRAN BLOCK DATAs generated by the input processor (sect 2.2.2) consist of two separate subprograms as a direct consequence of the division of input data into <u>simple variables</u> and <u>tables</u> (reference 5). If the <u>tables</u> block data for the whole scenario were compiled in toto as the result of a user override corresponding to a single table, an inordinate amount of computer time would be used. Therefore, an option to restrict the tables block data output to just the tables for which user overrides were received is included in the input processor software, and is automatically selected during execution of the simulation model. This necessitates the availability of a compiled version of the tables block data consisting of the default values for the scenario, to be loaded into memory prior to program execution. Another tables block data, consisting of tables overridden by the input, can be created and loaded prior to execution, effectively re-initializing the proper storage locations which contained the default values. Thus, the desired input (table) configuration is achieved.

The begin/revert procedure (reference 8) which causes the creation of a scenario is executed by the following control cards:

```
ATTACH,PROFIL,MSSBRPROCS,ID=NS2.
BEING,MSSOPT,I=infile,L=outfile,PFL=leadchar,ID=userid.
```

where

- infile = name of the local file containing input to the option processor (sect 3.1.1).
- outfile = name of the local file to which listable output is to be written.
- leadchar = up to 10 characters to be used as the leading characters of the permanent file name for each of the three files which will be catalogued.
- userid = the user identification to be associated with the permanent files catalogued. (This is the same ID parameter as is described in reference 7, chapter 5).

Any or all of the I, L, PFL, or ID parameters can be omitted, in which cases the defaults of INPUT, OUTPUT, null (no leading characters), and NS2 are used. Upon successful completion of the scenario definition phase the output file will contain a report which lists default values for all associated input data.

3.1.1 Option Processor. The contents of the three scenario-defining permanent files mentioned in section 3.1 are determined by the input submitted to the option processor program (sect 2.2.4). This input file, which corresponds to the "I" parameter of the BEGIN command (sect 3.1), must contain BCD card images of the following form:

columns 1-10:	option name	(left-justified, A10 format)
columns 21-30:	selection	(left-justified, A10 format)

The following options were available to the initial version of the model. The relevant selections are listed for each, with the default selection in the first position. The characters in parentheses which may follow each option or selection are what must actually be present in the input field, when a difference exists.

option	selections
fire control (FIRE CONT)	computed, nominal
midcourse guidance (MIDCOURSE)	command, internal
target tracking initialization (RADAR INIT)	intermediate (INTERMED), actual
homing	maximum, minimum
trajectory output (OUTPUT)	edited, unedited
imu gyros	strapdown, inertial

The nominal fire control selection causes the model's pre-launch fire control solution algorithm to be bypassed, and enables the fire control solution to be input. In general, edited trajectory output means a less lengthy output listing which is a subset of what would be generated by the unedited selection. The actual quantities which are printed depend on the midcourse guidance mode (command or internal) and which trajectory guidance phase (boost, midcourse, or terminal) is undergoing execution at the time of output. These can be identified, however, by consulting the PDL design document (reference 2). Discussions concerning the use of and mathematical formulation for the remainder of the options and their corresponding selections can be found in reference 1.

Up to 50 card images may be input to the option processor. The input file may contain multiple selections for the same option, but the last selection encountered is the one used to define the scenario. The default selection is used for options which are not specified. The program performs syntax checking operations on the input to detect illegal options, illegal selections, and illegal option-selection combinations. Any of

these types of errors causes a diagnostic message to be written to the output file, and further processing is inhibited. If no errors are found, UPDATE correction sets (reference 9) required for each of the three permanent files necessary for defining the scenario are written. These files consist primarily of *DEFINE directives which are subsequently used by the system UPDATE utility, in conjunction with special "decks" on the source library (Figure 1, Sect 2.4) to produce the desired permanent files. A more complete discussion concerning the correction sets, source library "decks", and the portion of the begin/revert procedure MSSOPT which controls this file generation process, is presented in section 4 of this document.

<u>3.1.2 Target Trajectory File</u>. As mentioned in reference 1, target trajectory data to be used by the simulation is previously generated and stored on a permanent file to be accessed by the program at execution time. It is therefore the user's responsibility to establish this file. The file's record format must be as follows: time in seconds, 3 position components (X, Y, Z) in feet, and 3 velocity components $(\dot{X}, \dot{Y}, \dot{Z})$ in feet/sec. These 7-computer-word (CDC) records must be in binary format (e.g. written by a standard FORTRAN unformatted WRITE), and contain equally-spaced increments of time. The permanent file name (reference 7) used for this file must consist of 10 or less characters, and the associated user ID must agree with the one used in the 'BEGIN' command of section 3.1.

<u>3.2 Simulation Execution</u>. Model execution is accomplished, using BEGIN/REVERT, by the following control cards:

```
ATTACH,PROFIL,MSSBRPROCS,ID=NS2.
BEGIN,MSSINIT,PFL=leadchar,TTRAJ=tgtfile,ID=userid.
BEGIN,MSSINP,I=infile,L=outfile.
```

where

leadchar = the leading (up to 10) characters of the (3) permanent files created when the scenario was defined.

tgtfile = the name (up to 10 characters) of the permanent file containing the target trajectory data.

userid = the user identification associated with all (4) permanent files described by the PFL and TTRAJ parameters.

infile = the name of the local file which contains the user input. The exact structure of this file, which need consist only of default data overrides, is described in reference 5, where a sample set up is also provided.

outfile = the name of the file to receive the listed output. This file will contain a listing of the input data, as generated by the input processor, and the results of the simulation. A sample printed portion which reflects the characteristics of this file is presented in appendix A.

A non-null character string should always be provided for the TTRAJ parameter. Any of the rest (PFL,ID,I,L) can be omitted, causing the defaults to be used. The defaults are, in order, null (no leading characters) NS2, INPUT, and OUTPUT.

SECTION 4. SYSTEM COMPONENTS

4.1 PDL Design Document. The modular design of the program is contained in this document, which is reference 2. The standards adopted for its construction are listed in the introductory segment titled "document conventions".

The source file responsible for the generation of the PDL document exists in UPDATE format (reference 9) on a permanent file named "MSSPDLUPDATE", which is backed up by the file of the same name on the NSWC/DL device set NUP076 (reference 10). A copy of the document may be obtained by executing the PDL processor (PDLA) with the following control cards:

```
ATTACH,OLDPL,MSSPDLUPDATE,ID=NS2.
UPDATE,F.
ATTACH,PDLA.
PDLA(COMPILE,PL=100000)
```

4.2 Execution - Controlling Begin/Revert Procedures.

4.2.1 Scenario Definition Procedure (MSSOPT). Figure 2 diagrams the scenario definition process in detail. Table 1 lists the associated begin/revert procedure of control cards, MSSOPT. Lines which begin with "/*" are comments. Following execution of the option processor (lines 3-5) a test is made for the local file INERR, whose existence signifies that a syntax error was detected while processing the user option overrides input. If an error condition exists, lines 8-9 are executed, causing the error message written by the option processor to be listed on the output file following which the procedure is exited (line 10). Otherwise, the initialization and control card permanent files are created by updating the proper deck on MSSOURCE as directed by the correction sets written by the option processor (OPINIT and OPCNTC) (lines 17-18), and cataloguing the resultant COMPILE files (lines 19-20). Note that the leading characters specified by the PFL parameter (sect 3.1) are concatenated with 'INITFILE' and 'PROCFILE' to form the respective permanent file names used during the CATALOG operation. The remainder of the procedure creates and catalogs the default table block data (sec 3.1). The correction set file DTBLKD, written by the option processor, causes an initialization file (SIMU11) to be written by the system UPDATE utility (line 24). This file differs from the initialization file just catalogued (INITPF) only in the symbolic subprogram name used to identify the tables block data (reference 3). This is necessary to avoid the duplicate entry point error condition which would occur later when the block datas were loaded during the model execution sequence. Using this file and the default file data base (SIMU13), the input processor writes the default table block data source (SIMU23) (line 27) which is compiled by line 30 and the object code (DEFTAB) catalogued by line 31.

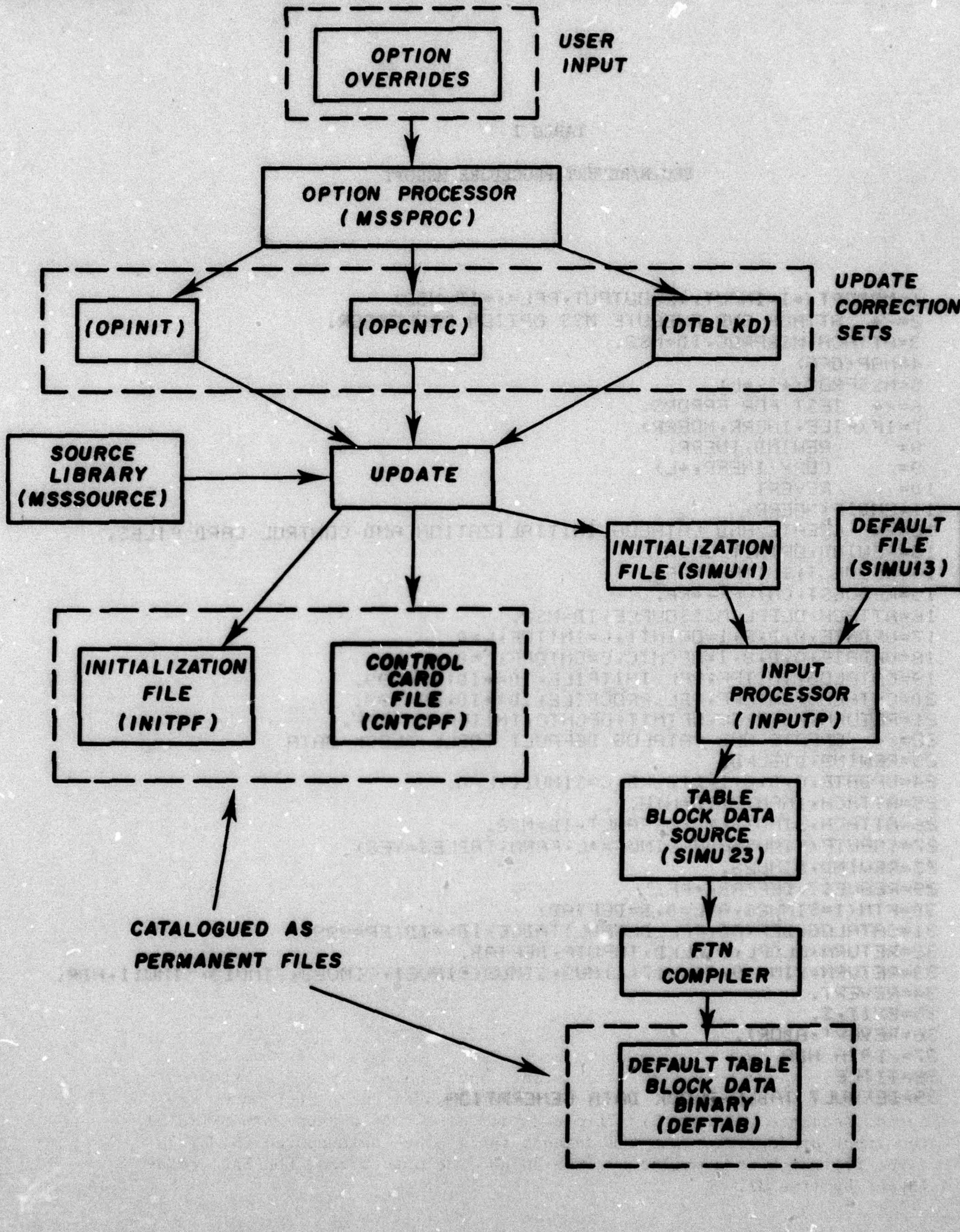


FIGURE 2. SCENARIO DEFINITION PROCESS

TABLE 1

BEGIN/REVERT PROCEDURE MSSOPT

```
 1=MSSOPT(◆I=INPUT,◆L=OUTPUT,PFL=,◆ID=NS2)
 2=/◆  ATTACH AND EXECUTE MSS OPTION PROCESSOR.
 3=ATTACH,MSSPROC,ID=NS2.
 4=MAP(OFF)
 5=MSSPROC(◆I,◆L)
 6=/◆  TEST FOR ERRORS.
 7=IF(FILE,INERR,NOERR)
 8=     REWIND,INERR.
 9=     COPY(INERR,◆L)
10=     REVERT.
11=ENDIF(NOERR)
12=/◆  CREATE AND CATALOG INITIALIZATION AND CONTROL CARD FILES.
13=REWIND,OPINIT,OPCNTC.
14=REQUEST,INITPF,◆PF.
15=REQUEST,CNTCPF,◆PF.
16=ATTACH,OLDPL,MSSSOURCE,ID=NS2.
17=UPDATE,Q,D,8,I=OPINIT,C=INITPF,L=0.
18=UPDATE,Q,D,8,I=OPCNTC,C=CNTCPF,L=0.
19=CATALOG,INITPF,PFL_INITFILE,ID=◆ID,RP=999.
20=CATALOG,CNTCPF,PFL_PROCFILE,ID=◆ID,RP=999.
21=RETURN,MSSPROC,OPINIT,OPCNTC,INITPF,CNTCPF.
22=/◆  CREATE AND CATALOG DEFAULT TABLE BLOCK DATA
23=REWIND,DTBLKD.
24=UPDATE,Q,D,8,I=DTBLKD,C=SIMU11,L=0.
25=ATTACH,INPUTP,ID=NTH.
26=ATTACH,SIMU13,MSSDEFAULT,ID=NS2.
27=INPUTP(SIMU5=HDR,SIMU6=◆L,PARM,TABLES=YES)
28=REWIND,SIMU23.
29=REQUEST,DEFTAB,◆PF.
30=FTN(I=SIMU23,A,L=0,B=DEFTAB)
31=CATALOG,DEFTAB,PFL_DEFAULTTABLE,ID=◆ID,RP=999.
32=RETURN,OLDPL,DTBLKD,INPUTP,DEFTAB.
33=RETURN,SIMU19,SIMU17,SIMU3,SIMU2,SIMU21,SIMU23,SIMU13,SIMU11,HDR.
34=REVERT.
35=EXIT,S.
36=REVERT,ABORT.
37=/DATA HDR
38=TITLE
39=DEFAULT TABLE BLOCK DATA GENERATION
```

The REVERT card (line 34) provides an exit from the procedure following normal (successful) execution, while the REVERT, ABORT directive (line 36) allows information regarding any fatal error condition to be passed to the calling procedure (user's control cards, sect 3.2). This exiting convention is used by all begin/revert procedures associated with the simulation.

Lines 37-39 cause the local file HDR to be created by BEGIN/REVERT, for use as input to INPUTP (line 27), thereby identifying the report subsequently generated. This listing, written to the output file, contains default values for all input items associated with the scenario.

4.2.2 Simulation Execution Procedures. As indicated in section 3.2, there are two begin/revert procedures which must be executed when the model is exercised. The following discussions provide a detailed description of each.

4.2.2.1 MSSINIT. The procedure MSSINIT (table 2), which is executed first, performs operations which need only be done one time regardless of how many times the simulation itself is run. These tasks primarily consist of accessing the permanent files required, by means of the ATTACH function. Among the files accessed are (lines 3-5): the input processor (INPUTP), the user library of simulation modules (MSSLIB), and the NSWC/DL system library (SYSLIB). Line 6 places MSSLIB and SYSLIB in the "global library set" (reference 6), which enables the system loader to satisfy external references (e.g. subroutine CALLs) with routines on these libraries. Lines 7-9 access the three permanent files established during scenario definition: initialization (SIMU11), procedure (MSSEXEC), and default table block data (DEFDAT). The PFL parameter, concatenated with the remainder of each permanent file name, and the ID parameter identify the previously established scenario of interest.

The target trajectory file (TAPE1) and the default file data base (SIMU13) are accessed by lines 10 and 11, while line 12 ensures that local files used by the input processer will not be already known to the job, when this usage later occurs.

4.2.2.2 MSSINP. The procedure MSSINP (table 3) executes the input processor, (INPUTP) (line 4) compiles the resultant block datas (lines 5-12) which reflect input variable overrides, issues the BEGIN command for the control card procedure MSS which actually executes the simulation (line 13), and re-begins itself in the event of another input "case" (reference 5) (lines 15-17). The general form of the procedure MSS is as follows:

MSS (*L=OUTPUT)

any LDSETs needed by the scenario

TABLE 2

BEGIN/REVERT PROCEDURE MSSINIT

```
1=MSSINIT(PFL=,TTRAJ=,*ID=NS2)
2=/*  ACCESS PERMANENT FILES NEEDED FOR EXECUTION
3=ATTACH,INPUTP,ID=NTH.
4=ATTACH,MSSLIB,ID=NS2.
5=ATTACH,SYSLIB.
6=LIBRARY(MSSLIB,SYSLIB)
7=ATTACH,SIMU11,PFL_INITFILE,ID=*ID.
8=ATTACH,MSSEXEC,PFL_PROCFILE,ID=*ID.
9=ATTACH,DEFDAT,PFL_DEFAULTTABLE,ID=*ID.
10=ATTACH,TAPE1,TTRAJ,ID=*ID.
11=ATTACH,SIMU13,MSSDEFAULT,ID=NS2.
12=RETURN,SIMU19,SIMU17,SIMU3,SIMU2.
13=REVERT.
14=EXIT,S.
15=REVERT,ABORT.
```

TABLE 3

BEGIN/REVERT PROCEDURE MSSINP

```
MSSINP(◆I=INPUT,◆L=OUTPUT)
RETURN,SIMU21,SIMU23.
REWIND,LGD21,LGD23.
INPUTP(SIMU5=◆I,SIMU6=◆L)
IF(FILE,SIMU21,GENS)
     REWIND,SIMU21.
     FTN(I=SIMU21,A,L=0,B=LGD21)
ENDIF(GENS)
IF(FILE,SIMU23,GENT)
     REWIND,SIMU23.
     FTN(I=SIMU23,A,L=0,B=LGD23)
ENDIF(GENT)
BEGIN,MSS,MSSEXEC,L=◆L.
/◆  EXECUTE ANOTHER CASE IF NECESSARY.
IF(-FILE,SIMU2,NXTCAS)
     BEGIN,MSSINP,I=◆I,L=◆L.
ENDIF(NXTCAS)
REVERT.
EXIT,S.
REVERT,ABORT.
```

```
LOAD(DEFDAT)
LOAD(LGO21)
LOAD(LGO23)
LIBLOAD(MSSLIB,MNEXEC)
EXECUTE(MNEXEC,*L)
REVERT.
EXIT,S.
REVERT,ABORT.
```

The procedure consists of the "load sequence" (reference 6) necessary for model execution. The LDSET cards (if any are present) indicate which substitutions are required. The default tables block data (DEFDAT) is loaded next followed by the file LGO23 which, if non-vacuous, contains default table overrides which will be loaded over the corresponding entities of DEFDAT. The file LGO21 initializes the simple variables appropriately, following which the entry point MNEXEC is loaded from the user library MSSLIB, as indicated by the LIBLOAD directive. Since MNEXEC is the main executive for the model, the resultant load file will contain all routines needed to run the desired scenario. Finally, execution is initiated via the EXECUTE command. Figure 3 provides a diagrammatic representation of the sequence of events leading up to program execution.

4.3 Source Library.

4.3.1 Library Structure. The source decks for all portions of the model reside, in UPDATE format, on the permanent file MSSSOURCE under the programmer ID NS2. The file is backed up by the identically named file on the device set NUP076. At this writing, no magnetic tape backup for the device set exists. The arrangement of the *DECKS on the library is given below; each element is discussed in a section to follow (4.3.2 - 4.3.8):

- common decks (4.3.2)
- subprogram source decks (4.3.3)
- initialization file deck (4.3.4)
- control card deck (4.3.5)
- default file deck (4.3.6)
- option processor source (4.3.7)
- begin/revert procedures source (4.3.8)

4.3.2 Common Decks. Labelled common blocks are the means used to globalize model variables. Each common block is associated with an UPDATE common deck on the source library in a one-to-one fashion.

Among the variables which reside in common are those which are inputs to the model. The common statement is a necessary vehicle of communication between the block datas constructed by the input processor and the routines of the program. Consequently, the common decks whose common blocks contain input variables are grouped together, and appear first on the source library. This is a mutually exclusive arrangement, i.e. no common block

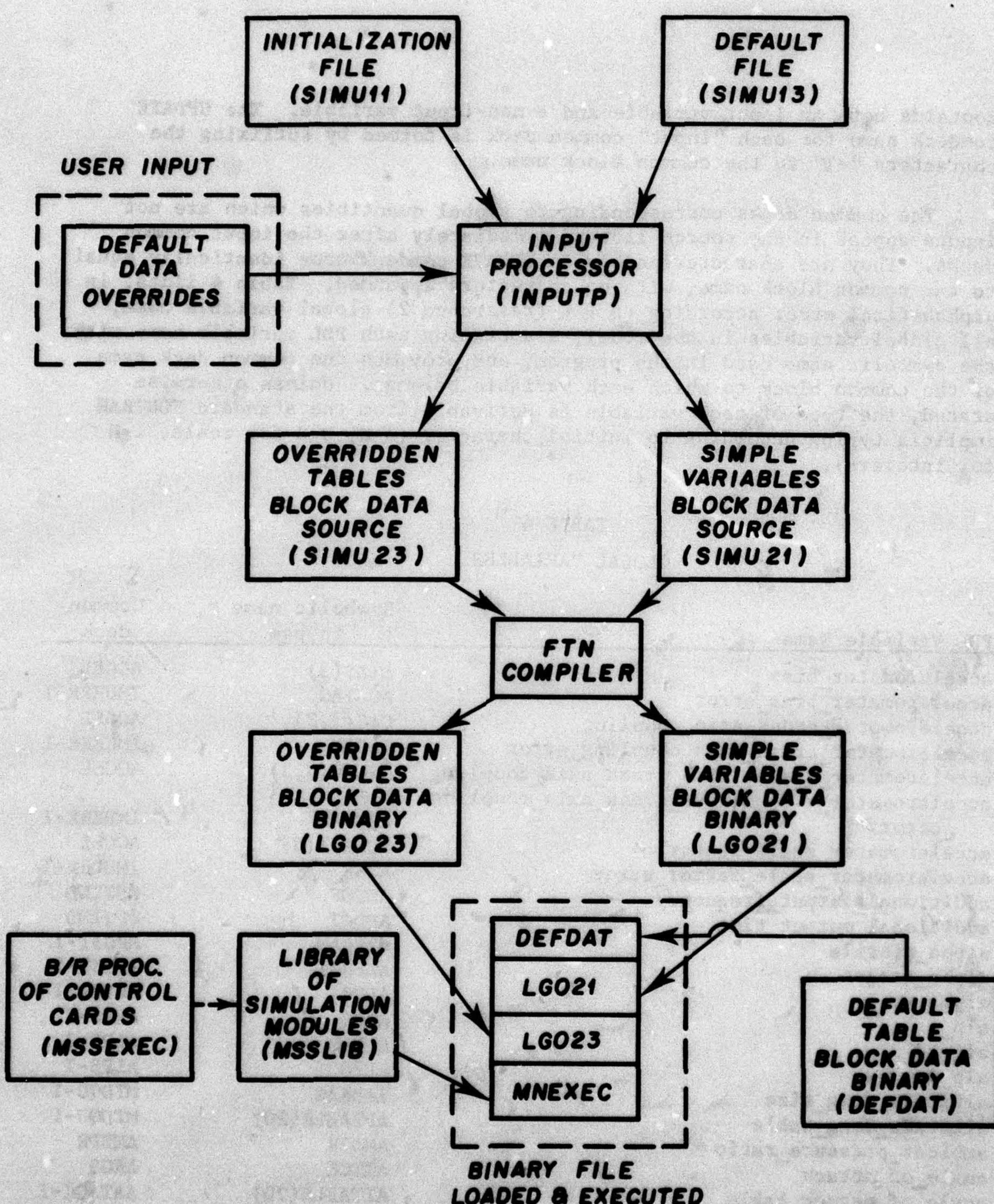


FIGURE 3. SIMULATION EXECUTION PROCESS

contains both an input variable and a non-input variable. The UPDATE comdeck name for each "input" common deck is formed by suffixing the characters "-I" to the common block name.

The common decks corresponding to global quantities which are not inputs appear in the source library immediately after the input common decks. They are characterized by an UPDATE comdeck name identically equal to the common block name, with no characters appended. Table 4 lists, in alphabetical order according to PDL (reference 2) global variable name, all global variables in the model, associating each PDL variable name with the symbolic name used in the program, and provides the common deck name of the common block to which each variable belongs. Unless otherwise stated, the type of each variable is derivable from the standard FORTRAN implicit typing according to initial character (A-H, O-Z for reals, I-N for integers).

TABLE 4

GLOBAL VARIABLES

PDL Variable Name	Symbolic name in pgm	Common deck
accelerometer_bias	BIAS(3)	ACCEL
accelerometer_bias_error	ACBIAS	IMUERR-I
accelerometer_cross_axis_coupling	CAC(3,3)	ACCEL
accelerometer_cross_axis_coupling_error	ACCAC	IMUERR-I
accelerometer_g_sensitive_cross_axis_coupling	GSCAC(3,3)	ACCEL
accelerometer_g_sensitive_cross_axis_coupling_error	ACGCAC	IMUERR-I
accelerometer_scale_factor	SCFACT(3)	ACCEL
accelerometer_scale_factor_error	ACSF	IMUERR-I
additional_output_frequency	ADDØF	ØUTIND
additional_output_time	ADDØT	ØUTIND
alpha_missile	ALPHAM	MFCST-I
alpha_target	ALPHAT	TFCST-I
alpha_vc	ALVC	NCVEL-I
alp_q	ALPQ	ALPS-I
alp_rd	ALPRD	ALPS-I
alp_0	ALPO	ALPS-I
altitude_drag_size	IADRAG	MTDQU-I
altitude_drag_table	ADTABLE(20)	MTDQU-I
ambient_pressure_ratio	AMBPR	AMBPR
angle_of_attack	ATTCK	ANGS
angle_of_attack_table	ATTABLE(20)	AATACK-I
angle_of_sideslip	SSLIP	ANGS
angular_signal_processing_noise	ASP	TNØISEI-I
anisoelastic_compliance_drift_rate	WC(3)	IMUGY
anisoelastic_compliance_drift_rate_error	ACDRIFT	IMUERR-I

PDL Variable Name	Symbolic name in pgm	Common deck
attack_angle_size	IASIZE	AATACK-I
autopilot_time_constant	ATC	ATC
azimuth_launch_angle	AZLAUN	LANGLES
azimuth_pointing_error	AZPERR	LERR-I
beta_missile	BETAM	MFCST-I
beta_target	BETAT	TFCST-I
body_fixed_acceleration	BA(3)	BFACC
body_pitch_angle	BPANG	BODYANG
body_roll_angle	BRANG	STATEV
body_seeker_matrix	ABS(3,3)	BSMAT
body_yaw_angle	BYANG	BØDYANG
boost_drag_table	BDTABLE(40)	BDRAGQU-I
boost_end_time	BENDT	BENDT-I
boost_guidance_gain	BØØGG	BØØQU-I
boost_thrust	BTHRUST	BTHRUST-I
burnout_trim_table	BTTABLE(20,20)	BLQUAN-I
burn_out_time	TBØ	TBØ-I
center_gravity_difference	CGD	CGD
center_gravity_factor	CGFACT	CGFACT
center_of_gravity	CG	CG
center_of_gravity_burnout	CGB	CGB-I
center_of_gravity_launch	CGL	CGL-I
center_of_gravity_table	CGTABLE(25)	MASQUAN-I
coefficient_exceeded_flag	CEXFLAG (logical)	CEXFLAG
commanded_pitch_acceleration	CPITCH	GUIDEC
commanded_roll_acceleration	CRØLL	GUIDEC
commanded_yaw_acceleration	CYAW	GUIDEC
computation_body_matrix	AC(3,3)	CBMAT
computed_acceleration	RC(3)	DV
computed_missile_position	PMC(3)	STATEV
computed_missile_velocity	VMC(3)	STATEV
corrected_density	RHØC	CØRDEN
C_B1	CB1	MPIP-I
C_B2	CB2	MPIP-I
defended_ship_x_coordinate	XDSHIP	THREAT-I
defended_ship_z_coordinate	ZDSHIP	THREAT-I
deg_rad	DEGRAD	CNSTS-I
delta_eg1	DTEG1	DEFFC-I
delta_eg2	DTEG2	DEFFC-I
delta_ko	DELKO	MRAC-I
delta_k1_max	DELK1MX	MRAC-I
delta_k2	DELK2	MRAC-I
delta_ri	DELTARI	DELTAS
delta_xi	DELTAXI	DELTAS
delta_zi	DELTAZI	DELTAS
density_error	DERR	ATQUAN-I
derivative_array	DV(17)	DV
doppler_velocity	DØPVEL	DØPVEL

PDL Variable Name	Symbolic name in pgm	Common deck
drag_coefficient	CD	DRAGCF
drift_matrix	D(3,3)	DRMAT
dynamic_pressure	Q	DYNPRES
earth_radius	ERRAD	ATQUAN-I
EG_L1	EGL1	DEFFC-I
EG_L2	EGL2	DEFFC-I
EG_O	EGO	TGPAR-I
EG_1		
EG_2	EGTABLE(3)	DEFFC-I
EG_3		
elevation_launch_angle	ELLAUN	LANGLES
elevation_pointing_error	ELPERR	LERR-I
estimated_flight_time	ESTIME	ESTIME
estimated_target_position	TLHAT(3)	ETP
E2_H	E2H	DEFFC-I
filtered_pitch_acceleration	FPITCH	FILTACC
filtered_roll_acceleration	FRØLL	FILTACC
filtered_yaw_acceleration	FYAW	FILTACC
GBØ_1	GBØ1	TGPAR-I
GBØ_2	GBØ2	TGPAR-I
glint_noise_constant	GLC	TNØISEI-I
gravity_constant	G	CNSTS-I
gyro_constant_drift_rate	WØ(3)	IMUGY
gyro_constant_drift_rate_error	GCDRIFT	IMUERR-I
gyro_drift_angle	GDANG(3)	STATEV
gyro_drift_rate	GDRATE(3)	DV
gyro_initialization_error	GYIERR	LERR-I
gyro_mass_unbalance_drift_rate	WM(3,2)	IMUGY
gyro_mass_unbalance_drift_rate_error	GMUDR	IMUERR-I
gyro_mass_unbalance_spin_axis_error	GMUSAP	IMUERR-I
g_bias	GBIAS	GBIAS
G_BO	GBO	TPNCV
G_B1	GB1	NCVEL-I
homing_handover_time	TSW	TSW
homing_lower_bound	HLB	MINHØM-I
homing_upper_bound	HUB	MINHØM-I
horizontal_range	HRANGE	HRANGE
H_O	HO	MPIP-I
H_ZØ	HZO	TGPAR-I
inertial_acceleration	AI(3)	INERACC
inertial_body_matrix	A(3,3)	IBMAT
inertial_velocity_matrix	AV(3,3)	IVMAT
initial_computation_body_row_vector	ACRV(3)	INACRV
initial_estimated_flight_time	EFTINT	TEFT-I
initial_predicted_missile_position	PREPØSM(3)	PVM-I
initial_predicted_target_position	PREPØST(3)	PVT-I
initial_smoothed_missile_velocity	SMVELM(3)	PVM-I

PDL Variable Name	Symbolic name in pgm	Common deck
initial_smoothed_target_velocity	SMVELT(3)	PVT-I
input_azimuth_launch_angle	AZLAUNI	NFC-I
input_elevation_launch_angle	ELLAUNI	NFC-I
input_estimated_flight_time	ESTIMEI	NFC-I
input_g_bø	GBOI	NFC-I
input_homing_handover_time	TSWI	NFC-I
input_integration_step_size	STEPIN	INSIZE-I
input_predicted_intercept_point	PREDINI(3)	NFC-I
integration_step_counter	INTSTEP	STEPCNT
input_t_bs	TBSI	NFC-I
input_vax_ø	VAXOI	NFC-I
integration_step_size	STEPSZE	STEPSZE
KH_1	KH1 (real)	MRAC-I
KH_2	KH2 (real)	MRAC-I
K_FB	KFB (real)	NCVEL-I
K_GB	KGB (real)	CAF-I
K_GØ	KGO (real)	CAF-I
K_mach	KMACH	KMACH
K_table	TABLEK(7,3)	TEFT-I
K_V1	KV1 (real)	MRAC-I
K_V2	KV2 (real)	MRAC-I
last_commanded_pitch_acceleration	PITCHL	LASTCØM
last_commanded_yaw_acceleration	YAWL	LASTCØM
launch_time	TLAUNCH	TLAUNCH-I
launch_transformation_matrix	TL(3,3)	TLMAT
launch_trim_table	LTTABLE(20,20)(real)	BLQUAN-I
launch_velocity	VLAUNCH	VLAUNCH-I
mach_drag_size	MDSIZE	MDQUAN-I
mach_drag_table	MDTABLE(40) (real)	MDQUAN-I
mach_number	MACHNO (real)	MACHNØ
mach_trim_factor	FACTMT	MATRQU-I
mach_trim_size	MTSIZE	MATROU-I
mach_trim_table	MTTABLE(20) (real)	MATRQU-I
mass_time_table	TMTABLE(25)	MASQUAN-I
maximum_normal_force_coefficient	FCNMAX	FCNMAX
maximum_seeker_gimbal_angle	SGMAX	SGMAX-I
maximum_target_angular_noise	TANMAX	TNØISEI-I
measured_acceleration	AM(3)	MEASACC
midcourse_filter_constant	FCMID	FCMID-I
midcourse_guidance_update_rate	GURMID	GURMID-I
midcourse_trajectory_update_rate	TURM	MTUR-I
missile_angular_noise	ANGM	MNØISE-I
missile_position	PM(3)	STATEV
missile_range_noise	RANM	MNØISE-I
missile_target_range	TMRANGE	TMRANGE
missile_target_unit_vector	TMUV(3)	TMUV
missile_total_velocity	VMTØT	VMTØT
missile_velocity	VM(3)	STATEV

PDL Variable Name	Symbolic name in pgm	Common deck
ncvel_flag	NCVFLAG (logical)	NCVFLAG
noisy_missile_position	PMN(3)	NØISEM
noisy_target_position	PTN(3)	NØISET
nominal_roll_angle	RØLLNØM	NØMRØLL-I
non_limited_acceleration (yaw & pitch)	YAWNL, PITCHNL	NLIMACC
normal_force_coefficient	FCN	FCN
n_boost_midcourse	NBMID	NBMID-I
n_terminal	NTERM	NTERM-I
pitch_line_of_sight_rate	PLØS	LSRATES
pitch_load_factor	PLDF	LDFACT
pitch_normal_force_coefficient	PNFC	NORMFC
pitch_seeker_gimbal_angle	PSGA	SGANG
pitch_seeker_look_angle	PSLA	SLANG
pitch_velocity_compensation	PVC	VELCOMP
polar_target_position	PTPØS(3)	PTPØS
power_off_drag_table	PØTABLE(40,20)	MTDQU-I
predicted_intercept_point	PREDIN(3)	PREDIN
prelaunch_radar_cycling_rate	PLCYCLE	PLCYCLE-I
previous_range	RPREV	RPREV
proportional_navigation_pitch_acceleration	PNPITCH	PNACC
proportional_navigation_yaw_acceleration	PNYAW	PNACC
Q_0104	Q0104	Q0104
rac_pitch_acceleration	RACPIT	RACACC
rac_roll_acceleration	RACRØL	RACACC
rac_yaw_acceleration	RACYAW	RACACC
rad_deg	RADDEG	CNSTS-I
range_glint_noise	RGLN	TNØISEI-I
range_noise_constant	RNC	TNØISEI-I
range_signal_processing_noise	RSP	TNØISEI-I
reference_area	RAREA	RAREA-I
rocket_thrust	RTHRST	RTHRST
RV_2	RV2	RV2
R2_H	R2H	DEFFC-I
seeker_field_of_view	SFV	SFV-I
simulation_time	TIME	STATEV
smoothed_missile_position	PMSM(3)	SMTRAJ
smoothed_missile_velocity	VMSM(3)	SMTRAJ
smoothed_target_position	PTSM(3)	STTRAJ
smoothed_target_velocity	VTSM(3)	STTRAJ
speed_of_sound	SSØUND	SSØUND
starting_simulation_time	SSTIME	SSTIME-I
state_variables	ST(17)	STATEV
sustain_drag_table	SDTABLE(40,20)	MTDQU-I
sustain_start_time	SUST	MTDQU-I
sustain_thrust	STHRUST	STHRUST-I
S_1	S1	MRAC-I
S_2	S2	MRAC-I

PDL Variable Name	Symbolic name in pgm	Common deck
target_acquisition_flag	TACQF	TACQF
target_acquisition_time	TACQ	TERMQ
target_angular_noise	TANØI	TNØISE
target_missile_body_axis (vector)	RB(3)	TMBAX
target_range_noise	TRNØI	TNØISE
target_time_at_launch	TLTIME	THREAT-I
tau_pressure_size	ITPSIZE	AUTØQU-I
tau_pressure_table	TPTABLE(50)	AUTØQU-I
tau_table	TATABLE(50)	AUTØQU-I
terminal_guidance_mode	MØDETG	MØDETG
terminal_guidance_time	TGT	TERMQ
terminal_guidance_update	TGUR	TGUR-I
tglim_1	TGLIM1	LIMTG-I
tglim_2	TGLIM2	LIMTG-I
thermal_noise_constant	TNC	TNØISEI-I
thrust_conversion	THCØNV	THRST-I
thrust_difference	THDIF	THDIF
thrust_table	THTABLE(20)	THRST-I
thrust_time_table	TTTABLE(20)	THRST-I
th_max	THMAX	MAXHØM-I
th_1, th_2, th_3, th_4, th_5	TH(5)	MINHØM-I
time_to_go	TGØ	TGØ
tm_indicator	TMIND	TMIND
total_attack_angle_burnout	TABØ	TABØ
total_attack_angle_launch	TALN	TALN
trajectory_output_frequency	TRAJØF	ØUTIND
trajectory_output_time	TRAJØT	ØUTIND
trajectory_update_time	TUTIME	TUTIME
transition_time	TRTIME	TRTIME-I
true_target_position	PTT(3)	TRPØS
true_target_velocity	VTT(3)	TRVEL
tsw_haw	TSWHAW	TSWHAW-I
T2_0	T20	TGPAR-I
T2_1	T21	TEFT-I
T2_2	T22	TEFT-I
T_BS1	TBS1	TGPAR-I
T_BS2	TBS2	TGPAR-I
T_BS	TBS	TBS
T_GS	TGS	TGS-I
T_H	THH	THH
T_VNR	TVNR	CAF-I
VAX_Ø	VAX0	TPNCV
VAX_1	VAX1	TGPAR-I
VAX_2	VAX2	TGPAR-I

PDL Variable Name	Symbolic name in pgm	Common deck
weight_burnout	WGTBØ	MASQUAN-I
weight_lbs	WEIGHT	WEIGHT
weight_table	WGTABLE(25)	MASQUAN-I
yaw_line_of_sight_rate	YLØS	LSRATES
yaw_load_factor	YLDF	LDFACT
yaw_normal_force_coefficient	YNFC	NØRMFC
yaw_seeker_gimbal_angle	YSGA	SGANG
yaw_seeker_look_angle	YSLA	SLANG
yaw_velocity_compensation	YVC	VELCØMP

4.3.3 Source Code Subroutine Decks. Decks containing the source code for the model's routines occur together on the source library, with each subprogram contained in a separate deck. The UPDATE *DECK names are identical to the FORTRAN subprogram symbolic names, in all cases. There also exists an exact correspondence between PDL (reference 2) "segments" and simulation model subprograms, which is given by table 5. The order of the entries in table 5 matches the order of the PDL segments in reference 2, which in turn coincides with the order of the decks on the source library.

The structured programming constructs which constitute the Program Design Language (reference 3) have been simulated in FORTRAN (reference 11), and were used when the source code was written. The lines of code are indented to denote the nesting of structures, thereby producing alignment with the PDL design document (reference 2).

The compilation object code output of these decks is used to generate the user library of simulation modules (sect 4.2.2), which is catalogued as the permanent file MSSLIB, ID=NS2. The actual library generation process is performed by the CDC EDITLIB user library generation utility (see reference 7).

TABLE 5

PDL SEGMENTS

vs.

SUBROUTINE SYMBOLIC NAMES

PDL Segment Name	Symbolic Name
Main executive routine	MNEXEC
Establish a fire control solution	ESTABFC
Input nominal fire control solution	INPUTFC
Compute fire control solution	CØMPFC
Compute estimated flight time	CØMPEFT
Calculate launch angles	CALCLA

PDL Segment Name	Symbolic Name
Compute terminal guidance parameters	TGPARM
Maximum homing handover time	MAXTSW
Minimum homing handover time	MINTSW
Determine trajectory initial conditions	LAUNCH
Launch initialization	LAUNCHI
Compute drift matrix D	DMATRIX
IMU sensor error levels	IMUSEL
Convert smoothed estimates to launch coordinates	CØNSLC
Kinematic executive	KINEXEC
Kinematic initialization	KINIT
Kinematic command boost phase	KCBØØST
Kinematic internal boost phase	KIBØØST
Kinematic command midcourse phase	KCMID
Kinematic internal midcourse phase	KIMID
Kinematic terminal guidance phase	KTERM
Compute short integration step	SHSTEP
Initiate kinematic command trajectory	BEGINC
Initiate kinematic internal trajectory	BEGINI
Command boost-midcourse IMU	IMUCBM
Internal boost-midcourse IMU	IMUIBM
Terminal IMU	IMUT
Kinematic autopilot	KAUTØ
Interpolate for autopilot time constant	TAUAP
Measured acceleration	MACC
Strap down gyro drift rates	STGYDR
Gyro drift rates	GYDR
Computed acceleration along IMU axes	IACC
Boost drag coefficient	CDBØØST
Midcourse-terminal drag coefficient	CDMIDT
Kinematic missile response to steering commands	KAERØ
Normal force coefficients	CNØRM
Maximum normal force coefficient	CNMAX
Kinematic angles of attack and sideslip	KANG
Interpolate for total attack angle launch	ALPTL
Interpolate for total attack angle burnout	ALPTBØ
Kinematic gravity free accelerations	GFACC
Inertial accelerations	INRACC
Table search	SEARCH
Runge Kutta integration	RKUTTA
Kinematic command missile trajectory	KCTRAJ
Kinematic internal missile trajectory	KITRAJ
Kinematic terminal missile trajectory	KTTRAJ
Command midcourse trajectory update check	TUCBM
Internal boost-midcourse trajectory update check	TUIBM
Boost guidance commands	BØØSTGC
Midcourse guidance commands	MIDGC
Midcourse PIP	MIDPIP
Midcourse commands in RAC axes	MIDRAC

PDL Segment Name	Symbolic Name
Transform to IRU axes and filter commands	TRFILT
Midcourse seeker gimbal angles	MSGA
Check for target acquisition	TAQCK
Target missile relative body axes vector	TMVECT
Terminal guidance update	TERMGU
Terminal phase seeker parameters	TSEEK
Body to seeker transformation matrix ABS	ABSMAT
Terminal guidance commands	TERMGC
Non-constant velocity compensation terms	NCVC
T test for non-constant velocity compensation	TTNVC
Compute and filter proportional navigation commands	CFPNC
Computation to body transformation matrix AC	ACMAT
Transform guidance commands to body axes	TGCBA
Kinematic inertial body transformation matrix A	AMATRIX
Kinematic inertial velocity transformation matrix AV	AVMAT
Obtain estimated target position and velocity from radar	ESTTRAJ
Convert to polar coordinates	PØLAR
Convert to rectangular coordinates	RECT
Target noise quantities	TARNSE
Add tracking noise	ADDNSE
Smooth noisy target trajectory	SMØØTHT
Intermediate filter initialization	FILTII
Actual filter initialization	FILTIA
Predicted position	PPØS
Obtain estimated missile position and velocity from radar	ESMTRAJ
Smooth noisy missile trajectory	SMØØTHM
Smoothed position and velocity	SPV
Determine true threat trajectory	DTTHRT
Atmospheric quantities	ATMØS
Kinematic thrust and mass properties	KTHM
Thrust	THR
Interpolation	INTERP
Kinematic mass properties	KMASS
Output launch quantities	ØLAUNCH
Compute output frequency indicators	ØFREQ
Edited kinematic command boost-midcourse trajectory output *(EKCBMTH)	EDKCBMT
Unedited kinematic command boost-midcourse trajectory output *(UKCBMTH)	UNKCBMT
Edited kinematic internal boost-midcourse trajectory output *(EKIBMTH)	

*(entry points for headings)

PDL Segment Name	Symbolic Name
Unedited kinematic internal boost-midcourse trajectory output *(UKIBMTH)	UNKIBMT
Edited kinematic terminal trajectory output *(EDKTTH)	EDKTT
Unedited kinematic terminal trajectory output *(UNKTTH)	UNKTT
Command boost-midcourse additional output *(CBMADDH)	CBMADD
Internal boost-midcourse additional output *(IBMADDH)	IBMADD
Terminal additional output *(TERADDH)	TERMADD

*(entry points for headings)

4.3.4 Initialization File Deck (INITDK). The initialization file deck (*DECK INITDK) is used during the scenario definition phase (sect 4.2.1) for dynamically constructing the initialization file required by the input processor. This file is actually the "compile file" output produced by UPDATE (Q mode, INITDK alone is written to compile file) when the deck is subjected to a correction set (*IDENT) comprised of *DEFINE directives (reference 9) which was written by the option processor as indicated by the input scenario. Correction sets to be applied to this deck exist on the local files OPINIT and DTBLKD following successful execution of the option processor (fig. 2, sect 4.2.1). A *DEFINE directive will be present on both files for each non-default option which the user has selected. The file DTBLKD will contain an additional *DEFINE directive (*DEFINE DTAB) which causes a different tables block data symbolic name to be used during the default tables block data generation, for the reason given in section 3.1, but the two files are otherwise identical.

The *DEFINE names used for each non-default option are identical to the character string used as input to the option processor to select the option, and appear as the non-default selection for each option in the chart presented in section 3.1.1.

As detailed in reference 5, the initialization file defines the input data environment for the scenario by assigning simple variables to classes, specifying vectors and tables, and defining the common block structure of the block datas to be constructed. The deck INITDK performs these specifications as required, but uses UPDATE *IF DEF, *IF -DEF, and *ENDIF directives to control parts of the deck which should/should not be written to the compile file, according to the non-default options contained in the scenario.

There are generally two option-input data relationships which require compile file control:

(1) an input variable is specifically required as the result of a non-default option being selected.
(2) the selection of a non-default option obseletizes a particular input variable.

Relationship (1) is represented on INITDK by a *IF DEF, optname ... *ENDIF directive pair, where optname represents the *DEFINE name associated with the (non-default) option, and the text between the pair of directives is the information to be placed on the initialization file when the option is selected. Relationship (2) is represented by a *IF -DEF, optname ... *ENDIF, where the text surrounded by the directive pair is not required by the initialization file when the option has been selected. If neither relationship is present (the information is always required by the initialization file), the text is not contained between any *IF DEF ... *ENDIF pair.

The foregoing selectivity scheme for constructing the initialization file dictates the following guidelines when the input data environment for a (conceivably new) option under consideration is being defined:

(1) "option boundaries" must not be crossed by the simple variables of one of the designated "classes" (see reference 5). That is, all variables in a class must exhibit relationship (1) to each non-default option, relationship (2) to each non-default option, or neither.

(2) "option boundaries" must not be crossed by any of the common blocks containing input variables and, consequently, by any of the "input" common decks on the source library.

4.3.5 Control Card Deck (CNTCDS). The control card deck (*DECK CNTCDS) is used during the scenario definition phase for constructing the begin/revert procedure MSS which ultimately executes the program. The general structure of this procedure is listed in section 4.2.2.2.

The routines of the simulation (source code subroutine decks) are coded with subroutine CALLs corresponding to the default selection for each option. No linkage to the subroutine sequences of non-default options is established. Consequently, the procedure MSS must contain LDSETs which cause the necessary substitutions to be made in the calling sequence, for each non-default option contained in the scenario. The general form of the LDSET constructed is:

$$\text{LDSET(SUBST=}a_1\text{-}b_1/a_2\text{-}b_2/\ldots/a_n\text{-}b_n)$$

where a_i = symbolic name of the pre-empted subroutine (entry point)

b_i = symbolic name of the subroutine (entry point) to be substituted for a_i

for $i = 1, 2, \ldots, n$.

The following list indicates the substitutions which are made for each non-default option selection:

Selection	Pre-empted entry point(s)	Substituted entry point(s)
nominal fire control	estabfc	inputfc
actual radar track filter initialization	filtii	filtia
minimum homing	maxtsw	mintsw
internal midcourse guidance	kcboost kcmid	kiboost kimid
unedited output and internal midcourse guidance (co-selected)	edkibmt ekibmth	unkibmt ukibmth
unedited output	edktt edktth	unktt unktth
unedited output, internal midcourse guidance not selected	edkcbmt ekcbmth	unkcbmt ukcbmth
inertial IMU gyros	stgydr	gydr

The procedure MSS is created by *DECK CNTCDS in exactly the same manner as the initialization file is produced by *DECK INITDK (sect 4.3.4). An UPDATE correction set consisting of *DEFINE directives is produced by the option processor and written to the local file OPCNTC (see fig. 2, sect 4.2.1). This *IDENT is then applied to CNTCDS and the compile file output consists of a procedure (named MSS) containing any LDSETS required by the scenario.

The *DEFINE names associated with the non-default options as specified by the directives written to OPCNTC are identical to those used for the other two correction set files (OPINIT and DTBLKD), and are identified in section 4.3.4. The deck (CNTCDS) itself thus contains *IF DEF, optname ... *ENDIF and *IF -DEF, optname ... *ENDIF directive pairs surrounding the LDSET card images, which cause the generation of an appropriate control card procedure compile file.

<u>4.3.6 Default File Deck (DEFDK)</u>. The default file, a required data base of the input processor, is independent of the scenario chosen; consequently, the same "worst case" file may be used each time the processor is executed. However, a default value must be present on the file for every quantity which is on the input list associated with at least one option selection (default or not).

The copy of the data base used by the input processor exists as the BCD permanent file MSSDEFAULT (ID=NS2), with the default file deck (*DECK DEFDK) serving as its source. The file itself is structured according to the specification listed in reference 5. The contents of the file are listed in appendix B of this document. The permanent version is created by updating DEFDK (Q mode) while specifying the D and 8 options on the UPDATE call card (reference 9), and cataloguing the resultant COMPILE file.

4.3.7 Option Processor Source (MSSPROC). The deck MSSPROC is the source for the FORTRAN program which serves as the option processor. The permanent file MSSPROC (ID=NS2) is the catalogued object code binary obtained by updating and compiling this deck, and is used in this form by the begin/revert procedure MSSOPT during scenario definition.

The exact functions performed by this program are discussed in section 3.1.1. The programming techniques used can be obtained by consulting a compilation listing.

4.3.8 Begin/Revert Procedures Source (BRPROCS). The permanent file MSSBRPROCS (ID=NS2) contains the begin/revert procedures MSSOPT, MSSINIT, and MSSINP (sect 4.2) which control the operation of both phases of the system (scenario definition and simulation execution).

The deck BRPROCS contains the source for these procedures. The permanent file version may be re-created by updating the deck (Q, D, 8 options selected) and cataloguing the compile file thus obtained.

REFERENCES

1. Stevens, F. L. and Weisel, J., Modular Weapon System Simulation - Structure and General Formulation, to be published.

2. McLaughlin, W., Missile System Simulation, PDL design document, 1978 (unpublished).

3. Caine, Farber & Gordon, Inc., Program Design Language Reference Guide (Processor Version 3), March, 1976.

4. Control Data Corporation, Fortran Extended Version 4 Reference Manual (Revised Edition), pub. no. 60305601.

5. Goyette, Peter J., User Guide for INPUTP (General Purpose Input Processor), NSWC/DL TN-K-18-78, December, 1978.

6. Control Data Corporation, Loader Version 1 Reference Manual, pub. no. 60344200.

7. Control Data Corporation, Scope Reference Manual, pub. no. 60307200.

8. NSWC/DL, Begin/Revert, 1977.

9. Control Data Corporation, Update Reference Manual, pub. no. 60342500.

10. NSWC/DL Guide to Device Sets, enclosure 2 of DK-74 memo of 03 May 1977.

11. Bevan, Robert T. and Reynolds, John H., Required Computer Programming/Coding Standards for Two FBM Weapon System Simulations (Appendix D), 1977.

Appendix A

Simulation Output

This appendix provides selected portions of the output produced by executing the model using a scenario which consisted of the unedited output and internal midcourse guidance option selections.

The report generated by the input processor (reference 5) is listed first, followed by the "launch quantities" output which provides values of initialized missile parameters at the start of the trajectory. Only the first pages of output generated by the boost, midcourse, and terminal trajectory phases are included in this appendix. The two types of output written during the trajectory ("trajectory" output and "additional" output) are intermixed, with "additional" output characterized by indented left margins. Note alignment with the headings which are written only once, at the beginning of each trajectory phase.

```
                                   * * * VARIABLES * * *

THREAT

    TLTIME   1.9000000000000E+01    XDSHIP   0.0000000000000E+00    ZDSHIP   0.0000000000000E+00

TARNOISE

    ALPHAT   3.0000000000000E-01    ASP      0.0000000000000E+00    BETAT    5.2900000000000E-02    GLC      0.0000000000000E+00
    RGLN     0.0000000000000E+00    RNC      0.0000000000000E+00    RSP      0.0000000000000E+00    TANMAX   0.0000000000000E+00
    TNC      0.0000000000000E+00

MTURATE

    TURN     2.5000000000000E-01

LAUNCH

    AZPERR   0.0000000000000E+00    RENDT    3.5000000000000E+00    ELPERR   0.0000000000000E+00    GYIERR   0.0000000000000E+00
   *ROLLNOM  4.5000000000000E+01    STEPIN   1.2500000000000E-01    TLAUNCH  2.5560000000000E-01    VLAUNCH  1.1997000000000E+02

BCOQUAN

    BOOGG    2.5785000000000E-02

MIDQUAN

    CB1      6.0000000000000E+00    CB2      1.0000000000000E-02    DELKO    1.8640000000000E-01    DELK1MX  1.0000000000000E+00
    DFLK2    2.0000000000000E+01    FCMID    9.3700000000000E-02    GURMID   2.5000000000000E-01    M0       4.0000000000000E+04
   *KM1     -4.6620000000000E-02    KM2      3.7296000000000E-01   *KV1     -4.6620000000000E-02    KV2      2.7972000000000E-01
    S1       2.3969000000000E-05    S2       5.7700000000000E-01

TERGUAN

    ALP0     2.4600000000000E-01    ALPRD    2.5880000000000E-04    ALPO     6.6700000000000E-01    ALVC     6.1440000000000E-03
    GP1      1.0000000000000E+00    KFA      3.5000000000000E-02    KGA      3.3333330000000E+00    KG0      4.0000000000000E+00
    TGLIM1   1.6600000000000E+00    TGLIM2   3.2000000000000E+01    TGS      2.0000000000000E+01

TGURATE

    TGUR     1.2500000000000E-01

SEEKER

    SFV      3.5000000000000E+00    SGMAX    5.0000000000000E+01    TRTIME   2.0000000000000E+00

THRUST
```

```
     THCONV   5.9800000000000E+02

ATMOS

     DEPR     0.0000000000000E+00     ERRAD    2.0855531000000E+07

MASS

     CGP      9.8550000000000E+01     CGL      1.1213000000000E+02     WGTBO    6.9979000000000E+02

AUTOPILOT

     ITPSIZE                9

GENAERO

     RTHRUST  2.1400000000000E+04     IADRAG                 6     MDSIZE                35     RAREA    9.9400000000000E-01
     STHRUST  2.5510000000000E+03     SUST     5.3900000000000E+00     TBO      3.0060000000000E+01

KINAERO

     IASIZE                11     MTSIZE                 8

IMUEPR

     ACBIAS   0.0000000000000E+00     ACCAC    0.0000000000000E+00     ACDRIFT  0.0000000000000E+00     ACGCAC   0.0000000000000E+00
     ACSF     0.0000000000000E+00     GCDRIFT  0.0000000000000E+00     GMUDR    0.0000000000000E+00     GMUSAP   0.0000000000000E+00

OUTPUT

     FULREP   NO                      MNOUT    NO                      NBMID                  1     NTERM                  1

CONSTANT

     DEGRAD   1.7453292519940E-02     G        3.2174050000000E+01     RADDEG   5.7295779510000E+01

NOMFC

     AZLAUNI  0.0000000000000E+00     ELLAUNI  6.0000000000000E+01     ESTIMEI  9.9000000000000E+01     TSWI     8.9534300000000E+01

TGPRM

     GMGI     1.0600000000000E+00     TMSI     2.9000000000000E+01     VAXOI    0.0000000000000E+00

                                  + + + VECTORS + + +

     PRFOINI  1.8000000000000E+05        2.0000000000000E+04        0.0000000000000E+00
    *PREPOST  4.2687506000000E+05        2.0000000000000E+04        0.0000000000000E+00
     SMVFLT  -2.5000000000000E+03        0.0000000000000E+00        0.0000000000000E+00
```

LAUNCH QUANTITIES:

ESTIMATED FLIGHT TIME (SEC)	99.00000
PREDICTED INTERCEPT POINT (FEET)	
X COMPONENT	150000.00000
Y COMPONENT	20000.00000
Z COMPONENT	0.60000
AZIMUTH LAUNCH ANGLE (DEG)	0.00000
ELEVATION LAUNCH ANGLE (DEG)	60.00000
HOMING HANDOVER TIME (SEC)	89.53430
TRS (SEC)	20.00000
GYRO DRIFT ANGLES (DEG)	
ROLL	0.00000
PITCH	0.00000
YAW	0.00000
BODY ANGLES (DEG)	
ROLL	45.00000
PITCH	60.00000
YAW	0.00000

```
TIME (SEC)        MISSILE POSITION (FEET)            MISSILE VELOCITY (FEET/SEC)          GYRO DRIFT ANGLES (DEG)
PHI (DEG)       COMP MISSILE POSITION (FEET)     COMP MISSILE VELOCITY (FEET/SEC)   THRST (LB)    WGT  (LB)    CG (CAL)
NON LIMITED ACC (G'S)    ALPHA (DG)  BETA (DEG)        BODY FIXED ACC (FT/SEC SQ)     .     INERTIAL ACC (FT/SEC SQ)
   GYRO DRIFT RATES (DEG/SEC)                 MEASURED ACC (FT/SEC SQ)           DYN PRES         CD           NORM FORCE COEFFS
---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------

    TIME (SEC)        SM TARGET POSITION (FT)               SM TARGET VELOCITY (FT/SEC)          COM YAW AC  COM PIT AC
    ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------

 .50000E+00  .20895E+02  .38183E+02 -.27442E-13  .11101E+03  .20882E+03 -.14230E-12 0.          0.          0.
 .45000E+02  .21165E+02  .38032E+02 -.23359E-13  .11110E+03  .20862E+03 -.18833E-12  .21400E+05  .13519E+04  .11165E+03
 .32092E-02 -.32092E-02  .26494E+00 -.26495E+00  .50975E+03  .10325E+00 -.10325E+00  .23573E+03  .45032E+03  .11595E-11
0.          0.          0.           .50875E+03  .10325E+00 -.10325E+00  .66479E+02  .36062E+00 -.65656E-01  .65656E-01

     .62500E+00  .42625E+06  .20000E+05 0.            -.25000E+04  .24633E-10 0.             .14890E+00 -.14890E+00

 .62500E+00  .36591E+02  .67599E+02 -.39301E-13  .14011E+03  .26192E+03 -.66489E-13 0.          0.          0.
 .45000E+02  .36097E+02  .67416E+02 -.39423E-13  .14050E+03  .26157E+03 -.77958E-13  .21401E+05  .13406E+04  .11149E+03
 .20328E-01 -.20328E-01  .10592E+01 -.10594E+01  .51275E+03  .65403E+00 -.65403E+00  .22900E+03  .45877E+03  .19362E-12
0.          0.          0.           .51275E+03  .65403E+00 -.65403E+00  .10474E+03  .34978E+00 -.26174E+00  .26174E+00

 .75000E+00  .55926E+02  .10369E+03 -.45891E-13  .16936E+03  .31552E+03 -.17713E-13 0.          0.          0.
 .45000E+02  .56273E+02  .10347E+03 -.47021E-13  .16959E+03  .31525E+03 -.38138E-13  .21401E+05  .13293E+04  .11133E+03
 .17960E-01 -.17960E-01  .64090E+00 -.64094E+00  .51677E+03  .57783E+00 -.57783E+00  .23648E+03  .45949E+03  .55067E-12
0.          0.          0.           .51677E+03  .57783E+00 -.57783E+00  .15213E+03  .33759E+00 -.15790E+00  .15790E+00

     .87500E+00  .42563E+06  .20000E+05 0.            -.25000E+04  .73900E-10 0.             .19037E-01 -.19037E-01

 .87500E+00  .78967E+02  .14650E+03 -.43553E-13  .19936E+03  .36931E+03  .36207E-13 0.          0.          0.
 .45000E+02  .79341E+02  .14624E+03 -.47662E-13  .19953E+03  .36907E+03  .25663E-13  .21402E+05  .13180E+04  .11117E+03
 .18099E-01 -.18099E-01  .46810E+00 -.46812E+00  .52083E+03  .58233E+00 -.58233E+00  .24138E+03  .46152E+03  .28777E-12
0.          0.          0.           .52083E+03  .58233E+00 -.58233E+00  .29869E+03  .32323E+00 -.11500E+00  .11500E+00

 .10000E+01  .10579E+03  .19604E+03 -.37186E-13  .22993E+03  .42338E+03  .61853E-13 0.          0.          0.
 .45000E+02  .10619E+03  .19576E+03 -.42381E-13  .23007E+03  .42316E+03  .57120E-13  .21403E+05  .13067E+04  .11101E+03
 .18607E-01 -.18607E-01  .36353E+00 -.36354E+00  .52495E+03  .59865E+00 -.59865E+00  .24565E+03  .46393E+03  .13856E-12
0.          0.          0.           .52495E+03  .59865E+00 -.59865E+00  .27468E+03  .30684E+00 -.89048E-01  .89048E-01

     .11250E+01  .42500E+06  .20000E+05 0.            -.25000E+04  .98534E-10 0.             .24097E-01 -.24097E-01

 .11250E+01  .13648E+03  .25237E+03 -.28192E-13  .26102E+03  .47777E+03  .83577E-13 0.          0.          0.
 .45000E+02  .13689E+03  .25205E+03 -.34053E-13  .26113E+03  .47756E+03  .77178E-13  .21404E+05  .12954E+04  .11085E+03
 .19654E-01 -.19654E-01  .29942E+00 -.29942E+00  .52914E+03  .63236E+00 -.63236E+00  .24947E+03  .46664E+03  .21139E-12
0.          0.          0.           .52914E+03  .63236E+00 -.63236E+00  .35023E+03  .28885E+00 -.73132E-01  .73132E-01

 .12500E+01  .17107E+03  .31551E+03 -.15149E-13  .29256E+03  .53252E+03  .13346E-12 0.          0.          0.
 .45000E+02  .17150E+03  .31517E+03 -.22139E-13  .29266E+03  .53232E+03  .11855E-12  .21405E+05  .12840E+04  .11069E+03
 .21281E-01 -.21281E-01  .25918E+00 -.25918E+00  .53341E+03  .68468E+00 -.68468E+00  .25300E+03  .46959E+03  .60218E-12
0.          0.          0.           .53341E+03  .68468E+00 -.68468E+00  .43551E+03  .27159E+00 -.63123E-01  .63123E-01
```

```
TIME (SEC)       MISSILE POSITION (FEET)           MISSILE VELOCITY (FEET/SEC)          GYRO DRIFT ANGLES (DEG)
PHI (DEG)      COMP MISSILE POSITION (FEET)      COMP MISSILE VELOCITY (FEET/SEC)   THRST (LB)   WGT  (LB)   CG (CAL)
NON LIMITED ACC (G'S)    ALPHA (DG)  BETA (DEG)    BODY FIXED ACC (FT/SEC SQ)           INERTIAL ACC (FT/SEC SQ)
   GYRO DRIFT RATES (DEG/SEC)              MEASURED ACC (FT/SEC SQ)         DYN PRES     CD          NORM FORCE COEFFS
---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------

     TIME (SEC)      SM TARGET POSITION (FT)              SM TARGET VELOCITY (FT/SEC)        COM YAW AC  COM PIT AC
     ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------

 .36250E+01  .16251E+04  .28690E+04  .26925E-12  .94546E+03  .16376E+04 -.15986E-12 0.          0.          0.
 .45000E+02  .16257E+04  .28642E+04  .26247E-12  .94556E+03  .16374E+04 -.16026E-12  .21455E+05  .10692E+04  .10765E+03
 .17546E+00 -.17546E+00  .23861E+00 -.23861E+00  .59829E+03  .56453E+01 -.56453E+01  .28915E+03  .52384E+03 -.44054E-12
0.          0.          0.           .59829E+03  .56453E+01 -.56453E+01  .39273E+04  .49285E+00 -.48058E-01  .48058E-01

       .36250E+01  .41875E+06  .20000E+05 0.          -.25000E+04  .39414E-09 0.            .22110E+00 -.22110E+00

 .37500E+01  .17454E+04  .30773E+04  .24671E-12  .97947E+03  .16954E+04 -.19746E-12 0.          0.          0.
 .45000E+02  .17461E+04  .30765E+04  .23984E-12  .97957E+03  .16952E+04 -.19875E-12  .20213E+05  .10579E+04  .10749E+03
 .19617E+00 -.19617E+00  .23888E+00 -.23888E+00  .56354E+03  .63115E+01 -.63115E+01  .27127E+03  .49403E+03 -.22737E-12
0.          0.          0.           .56354E+03  .63115E+01 -.63115E+01  .41858E+04  .49449E+00 -.49878E-01  .49878E-01

 .38750E+01  .18699E+04  .32926E+04  .22062E-12  .10115E+04  .17493E+04 -.21848E-12 0.          0.          0.
 .45000E+02  .19705E+04  .32917E+04  .21356E-12  .10115E+04  .17491E+04 -.22036E-12  .18970E+05  .10466E+04  .10733E+03
 .14627E+00 -.14627E+00  .16086E+00 -.16086E+00  .52811E+03  .47060E+01 -.47060E+01  .25676E+03  .46154E+03 -.12799E-12
0.          0.          0.           .52811E+03  .47060E+01 -.47060E+01  .44304E+04  .40670E+00 -.34762E-01  .34762E-01

       .38750E+01  .41813E+06  .20000E+05 0.          -.25000E+04  .41077E-09 0.            .88889E-01 -.88889E-01

 .40000E+01  .19992E+04  .35143E+04  .19261E-12  .10415E+04  .17991E+04 -.22884E-12 0.          0.          0.
 .45000E+02  .19988E+04  .35135E+04  .18520E-12  .10415E+04  .17989E+04 -.23191E-12  .17720E+05  .10353E+04  .10717E+03
 .11961E+00 -.11961E+00  .11979E+00 -.11979E+00  .49200E+03  .38483E+01 -.38483E+01  .24052E+03  .42924E+03 -.56843E-13
0.          0.          0.           .49200E+03  .38493E+01 -.38483E+01  .46589E+04  .43944E+00 -.26740E-01  .26740E-01

 .41250E+01  .21301E+04  .37421E+04  .16352E-12  .10696E+04  .18447E+04 -.23572E-12 0.          0.          0.
 .45000E+02  .21308E+04  .37412E+04  .15567E-12  .10696E+04  .18445E+04 -.23938E-12  .16486E+05  .10240E+04  .10701E+03
 .41092E-01 -.41092E-01  .37794E-01 -.37794E-01  .45521E+03  .13221E+01 -.13221E+01  .22636E+03  .39495E+03 -.31974E-13
0.          0.          0.           .45521E+03  .13221E+01 -.13221E+01  .48695E+04  .41271E+00 -.86932E-02  .86932E-02

       .41250E+01  .41750E+06  .20000E+05 0.          -.25000E+04  .46804E-09 0.           -.45855E-01  .45855E-01

 .42500E+01  .22654E+04  .39752E+04  .13396E-12  .10959E+04  .18860E+04 -.23647E-12 0.          0.          0.
 .45000E+02  .22661E+04  .39743E+04  .12564E-12  .10958E+04  .18858E+04 -.24049E-12  .15243E+05  .10127E+04  .10605E+03
-.17342E-03  .17342E-03 -.14757E-03  .14757E-03  .41769E+03 -.55795E-02  .55795E-02  .23985E+03  .36115E+03  .10301E-13
0.          0.          0.           .41769E+03 -.55795E-02  .55795E-02  .50605E+04  .41677E+00  .34913E-04 -.34913E-04

 .43750E+01  .24039E+04  .42133E+04  .10438E-12  .11199E+04  .19229E+04 -.23708E-12 0.          0.          0.
 .45000E+02  .24046E+04  .42124E+04  .95595E-13  .11199E+04  .19227E+04 -.24071E-12  .14001E+05  .10014E+04  .10669E+03
-.07955E-01  .07955E-01 -.70935E-01  .70935E-01  .37929E+03 -.28299E+01  .28299E+01  .19492E+03  .32539E+03 0.
0.          0.          0.           .37928E+03 -.28299E+01  .28299E+01  .52392E+04  .42248E+00  .16942E-01 -.16942E-01
```

```
TIME (SEC)       MISSILE POSITION (FEET)          MISSILE VELOCITY (FEET/SEC)       THRST (LB)   WGT (LB)     CG (CAL)
NON LIMITED ACC (G'S)   ALPHA (DG)  BETA (DEG)      BODY FIXED ACC (FT/SEC SQ)            INERTIAL ACC (FT/SEC SQ)
    MEASURED ACC (FT/SEC SQ)           DYN PRES       CD          NORM FORCE COEFFS
---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------

     TIME (SEC)       TRUE TARGET POSITION (FT)          TRUE TARGET VELOCITY (FT/SEC).     COM YAW AC  COM PIT AC
      LOS RATES (DEG/SEC)     SEEKR GIMB ANG (DEG)      DOP VEL     TGO (SEC)   THRNG (FT)
     ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------

 .89750E+02  .17140E+06  .25130E+05 -.60919E-11  .13421E+04 -.67109E+03  .13301E-11 0.              .69979E+03  .98550E+02
 .80392E+00 -.80392E+00  .30305E+01 -.30347E+01 -.35716E+02  .28439E+02 -.28439E+02 -.17778E+02  .50765E+02 -.22737E-12
-.35716E+02  .28439E+02 -.28439E+02  .11917E+04  .65501E+00 -.52221E+00  .52221E+00

     .89750E+02  .28313E+06  .20000E+05 0.            -.25000E+04 0.           0.            .11697E+01 -.11697E+01
     .60107E-01 -.60107E-01  .93479E+01  .92259E+01 -.39001E+04  .82393E+01  .32134E+05

 .89875E+02  .17157E+06  .25054E+05 -.67274E-11  .13400E+04 -.66931E+03  .12875E-11 0.              .69979E+03  .98550E+02
 .97770E+00 -.97770E+00  .32499E+01 -.32542E+01 -.35729E+02  .31459E+02 -.31459E+02 -.16515E+02  .54619E+02 -.68212E-12
-.35729E+02  .31459E+02 -.31499E+02  .11903E+04  .65681E+00 -.57831E+00  .57831E+00

     .89875E+02  .28281E+06  .20000E+05 0.            -.25000E+04 0.           0.            .14560E+01 -.14560E+01
     .59282E-01 -.59292E-01  .90939E+01  .89815E+01 -.38976E+04  .81196E+01  .31647E+05

 .90000E+02  .17174E+06  .24970E+05 -.65748E-11  .13381E+04 -.66607E+03  .11312E-11 0.              .69979E+03  .98550E+02
 .11340E+01 -.11340E+01  .36119E+01 -.36190E+01 -.35739E+02  .36512E+02 -.36512E+02 -.14405E+02  .61104E+02 -.18190E-11
-.35739E+02  .36512E+02 -.36512E+02  .11888E+04  .65783E+00 -.67207E+00  .67207E+00

     .90000E+02  .28250E+06  .20000E+05 0.            -.25000E+04 0.           0.            .17410E+01 -.17410E+01
     .57506E-01 -.57596E-01  .86729E+01  .85752E+01 -.38952E+04  .79996E+01  .31160E+05

 .90125E+02  .17191E+06  .24897E+05 -.64503E-11  .13364E+04 -.66190E+03  .83509E-12 0.              .69979E+03  .98550E+02
 .13341E+01 -.13341E+01  .40710E+01 -.40821E+01 -.35742E+02  .42923E+02 -.42923E+02 -.12110E+02  .69393E+02 -.29559E-11
-.35742E+02  .42923E+02 -.42923E+02  .11870E+04  .65989E+00 -.79129E+00  .79128E+00

     .90125E+02  .28219E+06  .20000E+05 0.            -.25000E+04 0.           0.            .20266E+01 -.20266E+01
     .54565E-01 -.54565E-01  .81263E+01  .80457E+01 -.38929E+04  .78793E+01  .30673E+05

 .90250E+02  .17207E+06  .24805E+05 -.63755E-11  .13351E+04 -.65661E+03  .31403E-12 0.              .69979E+03  .98550E+02
 .15614E+01 -.15614E+01  .45970E+01 -.46110E+01 -.35737E+02  .50236E+02 -.50236E+02 -.97242E+01  .78929E+02 -.54570E-11
-.35737E+02  .50236E+02 -.50236E+02  .11848E+04  .66003E+00 -.92780E+00  .92780E+00

     .90250E+02  .28188E+06  .20000E+05 0.            -.25000E+04 0.           0.            .23104E+01 -.23104E+01
     .49852E-01 -.49852E-01  .74819E+01  .74189E+01 -.38907E+04  .77587E+01  .30187E+05

 .90375E+02  .17224E+06  .24723E+05 -.63830E-11  .13340E+04 -.65007E+03 -.46283E-12 0.              .69979E+03  .98550E+02
 .18071E+01 -.18071E+01  .51663E+01 -.51875E+01 -.35722E+02  .58141E+02 -.58141E+02 -.75308E+01  .89332E+02 -.68212E-11
-.35722E+02  .58141E+02 -.58141E+02  .11921E+04  .66124E+00 -.10762E+01  .10762E+01

     .90375E+02  .28156E+06  .20000E+05 0.            -.25000E+04 0.           0.            .25927E+01 -.25927E+01
```

APPENDIX B

LISTING OF DEFAULT FILE

THREAT			
	XDSHIP	0.0	DEFENDED SHIP X-COORDINATE (FEET)
	ZDSHIP	0.0	DEFENDED SHIP Z-COORDINATE (FEET)
	TLTIME	10.0	TARGET TIME AT LAUNCH (SEC)
TARNOISE			
	ALPHAT	0.3	POSITION SMOOTHING FILTER CONSTANT TGT.
	ASP	0.0	ANGULAR SIGNAL PROCESSING NOISE (MRAD)
	BETAT	0.0529	VELOCITY SMOOTHING FILTER CONSTANT TGT.
	GLC	0.0	GLINT NOISE CONSTANT (MRAD-NM)
	TANMAX	0.0	MAXIMUM TARGET ANGULAR NOISE (MRAD)
	RGLN	0.0	RANGE GLINT NOISE (FEET)
	RNC	0.0	RANGE NOISE CONSTANT (FEET)
	RSP	0.0	RANGE SIGNAL PROCESSING NOISE (FEET)
	TNC	0.0	THERMAL NOISE CONSTANT (MRAD/NM(SQ))
MTURATE			
	TURM	0.25	MIDCOURSE TRAJECTORY UPDATE RATE (SEC)
STARTIME			
	SSTIME	-10.0	STARTING SIMULATION TIME (SEC)
LAUNCH			
	AZPERR	0.0	AZIMUTH POINTING ERROR (DEG)
	ELPERR	0.0	ELEVATION POINTING ERROR (DEG)
	GYIERR	0.0	GYRO INITIALIZATION ERROR (DEG)
	ROLLNOM	-45.0	NOMINAL ROLL ANGLE (DEG)
	BENDT	3.5	BOOST END TIME (SEC)
	STEPIN	0.125	INPUT INTEGRATION STEP SIZE (SEC)
	TLAUNCH	0.2556	LAUNCH TIME (SEC)
	VLAUNCH	119.97	LAUNCH VELOCITY (FT/SEC)
BOOQUAN			
	BOOGG	0.025785	BOOST GUIDANCE GAIN (G'S/FEET/SEC)
MIDQUAN			
	CB1	6.0	(SEC)
	CB2	0.01	(SEC(INV))
	DELK0	0.10648	(G'S/(YD/SEC(SQ)))
	DELK1MX	1.0	
	DELK2	20.0	(SEC)
	H0	40000.0	(FT)
	KH1	-0.04462	(G'S/(YD/SEC(SQ)))
	KH2	0.37296	(G'S/(YD/SEC(SQ)))
	KV1	-0.04462	(G'S/(YD/SEC(SQ)))
	KV2	0.27972	(G'S/(YD/SEC(SQ)))
	FCMID	0.0937	MIDCOURSE FILTER CONSTANT
	GURMID	0.25	MIDCOURSE GUIDANCE UPDATE RATE (SEC)
	S1	2.3969E-5	(1/YD)
	S2	0.577	
TERQUAN			
	ALVC	0.006144	
	KFB	0.035	
	KGB	3.333333	
	KG0	4.0	
	TGS	20.0	(SEC)
	GB1	1.0	
	ALP0	0.667	
	ALPRO	0.0002588	
	TGLIM1	1.66	(G'S)

	TGLIM2	32.0	
	ALP0	0.246	
TGURATE			
	TGUR	0.125	TERMINAL GUIDANCE UPDATE RATE (SEC)
SEEKER			
	TRTIME	2.0	TRANSITION TIME (SEC)
	SGMAX	50.0	MAXIMUM SEEKER GIMBAL ANGLE (DEG)
	SFV	3.5	SEEKER FIELD OF VIEW (DEG)
THRUST			
	THCONV	590.0	THRUST CONVERSION (LBS)
ATMOS			
	DERR	0.0	DENSITY ERROR (%)
	ERRAD	20855531.0	EARTH RADIUS (FEET)
MASS			
	CGL	112.13	CENTER OF GRAVITY - LAUNCH (IN)
	CGB	98.55	CENTER OF GRAVITY - BURNOUT (IN)
	WGTBO	699.79	WEIGHT - BURNOUT (LBS)
AUTOPILOT			
	ITPSIZE	9	TAU TABLE SIZE
GENAERO			
	IADRAG	6	ALTITUDE DRAG TABLE SIZE
	BTHRUST	21400.0	BOOST THRUST (LBS)
	TBO	30.06	BURN OUT TIME (SEC)
	MDSIZE	35	MACH DRAG TABLE SIZE
	SUST	5.39	SUSTAIN START TIME (SEC)
	STHRUST	2551.0	SUSTAIN THRUST (LBS)
	RAREA	0.994	REFERENCE AREA (SQ FT)
KINAERO			
	IASIZE	11	ANGLE OF ATTACK TABLE SIZE
	MTSIZE	8	MACH TRIM TABLE SIZE
IMUERR			
	ACBIAS	0.0	ACCELEROMETER BIAS ERROR (G'S)
	ACCAC	0.0	ACC. CROSS AXIS COUPLING ERROR (%)
	ACGCAC	0.0	ACC. G-SENSITIVE CR. AXIS COUP. ERR. (%)
	ACSF	0.0	ACC. SCALE FACTOR ERROR (%)
	ACDRIFT	0.0	ANISOELASTIC COMP. DR. RATE ERROR (D/H/G
	GCDRIFT	0.0	GYRO CONSTANT DRIFT RATE ERROR (DEG/HR)
	GMUDR	0.0	GYRO MASS UNBAL. DR. RATE ERROR (D/H/G)
	GMUSAP	0.0	GYRO MASS UNBAL SP. AXIS ERROR (DG/HR/G2
OUTPUT			
	NBMID	1	OUTPUT FREQUENCY (# INT. STEPS) (BO-MID)
	NTERM	1	OUTPUT FREQUENCY (# INT. STEPS) (TERM)
	MNOUT	NO	INCLUDE/INHIBIT INPUT DATA MNEMONICS
	FULREP	NO	DESELECT/SELECT FULL INPUT REPORT
CONSTANT			
	DEGRAD	0.01745329251994	DEGREES TO RADIANS (RAD/DEG)
	G	32.17405	GRAVITY CONSTANT (FT/SEC(SQ))
	RADDEG	57.29577951	RADIANS TO DEGREES (DEG/RAD)
DEFFC			
	PLCYCLE	0.25	PRELAUNCH RADAR CYCLING RATE (SEC)
	T21	25.0	(SEC)
	T22	70.0	(SEC)
	EFTINT	99.0	INITIAL ESTIMATED FLIGHT TIME (SEC)
	E2M	94.0	(DEG)

```
          R2H             10000.0          (YD)
          TSWHAM              3.50         HOMING TIME ALL THE WAY (SEC)
          DTEG1               0.00105      (DEG/YD)
          DTEG2              11.0          (DEG)
          EGL1               90.0          (DEG)
          EGL2               60.0          (DEG)
          TBS1               29.0          (SEC)
          TBS2                7.5          (SEC)
          HZ0              1670.0          (YD)
          T20                42.10         (SEC)
          VAX1                0.0          (G'S)
          VAX2               -3.0          (G'S)
          EG0                65.0          (DEG)
          GBO1                0.0          (G'S)
          GBO2                1.06         (G'S)
MAXHOM
          THMAX              23.0          (SEC)
MISNOISE
          ALPHAM              0.3          POSITION SMOOTHING FILTER CONSTANT MIS.
          BETAM               0.0529       VELOCITY SMOOTHING FILTER CONSTANT MIS.
          ANGM                0.0          MISSILE ANGULAR NOISE (MRAD)
          RANM                0.0          MISSILE RANGE NOISE (FT)
HOMFC
          AZLAUNI             0.0          AZIMUTH LAUNCH ANGLE (DEG)
          ELLAUNI            60.0          ELEVATION LAUNCH ANGLE (DEG)
          ESTIMEI            99.0          ESTIMATED FLIGHT TIME (SEC)
          TSWI               89.5343       HOMING HANDOVER TIME (SEC)
TGPRM
          GB0I                1.06         (G'S)
          TBSI               29.0          (SEC)
          VAX0I               0.0          TERMINAL GUIDANCE PARAMETERS (G'S)
MINHOM
          MLB                 0.0          HOMING LOWER BOUND (SEC)
          MUB                10.0          HOMING UPPER BOUND (SEC)
VECTORS
          EGTABLE
                     0.96           0.0008      4.1
          PREPOSM                          INITIAL PREDICTED MISSILE POSITION (FT)
                  1513.0         2461.0         0.0
          SMVELM                           INITIAL SMOOTHED MISSILE VEL. (FT/SEC)
                   926.0         1500.0         0.0
          PREPOST                          INITIAL PREDICTED TARGET POSITION (FT)
                452500.0        20000.0         0.0
          SMVELT                           INITIAL SMOOTHED TARGET VEL. (FT/SEC)
                 -2500.0            0.0         0.0
          PREDINI                          PREDICTED INTERCEPT POINT (FT)
                100000.0        20000.0         0.0
TABLES
          THTABLE        5                 THRUST TABLE (LBS)
               21400.0   21400.0    2551.0    2551.0    0.0
          TTTABLE        5                 THRUST TIME TABLE (SEC)
                   0.0      3.50      5.39     22.77   30.06
          CGTABLE        4                 CENTER OF GRAVITY TABLE (IN)
               112.13    106.41     90.55     90.55
```

```
THTABLE        4                      MASS TIME TABLE (SEC)
     0.0      4.47     26.34     30.06
WGTABLE        4                      WEIGHT TABLE (LBS)
  1385.0    981.49    699.79     699.79
TPTABLE        9                      TAU DYNAMIC PRESSURE TABLE (LBS/FT(SQ))
            150.0     350.0      500.0
            700.0    1100.0     2150.0
           3350.0    4250.0     6700.0
TATABLE        9                      TAU TABLE (SEC)
              1.0       0.55       0.44
              0.375     0.32       0.25
              0.22      0.205      0.17
ADTABLE        6                      ALTITUDE DRAG TABLE (FEET)
     0.0    20000.0   40000.0   60000.0   80000.0   100000.0
ATTABLE       11                      ANGLE OF ATTACK TABLE (DEG)
     0.0  4.0  8.0 12.0 16.0 20.0 24.0 28.0 32.0 36.0 40.0
BDTABLE       35                      BOOST DRAG TABLE
          0.387       0.378       0.363       0.343       0.317
          0.285       0.255       0.247       0.245       0.246
          0.265       0.346       0.420       0.446       0.460
          0.467       0.467       0.459       0.447       0.433
          0.420       0.405       0.388       0.372       0.355
          0.345       0.339       0.335       0.334       0.334
          0.334       0.334       0.334       0.334       0.334
BTTABLE        8                      BURNOUT TRIM TABLE (NORM. FORCE COEF.)
           0.0  0.8  1.7  2.8  3.9  5.0  6.2  7.3  8.9 10.2
          11.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  0.8  1.7  2.8  3.9  5.0  6.2  7.3  8.9 10.2
          11.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  0.8  1.7  2.8  4.0  5.2  6.7  8.5 10.7 12.8
          14.6  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  0.6  1.7  2.9  4.1  5.6  7.6  9.5 11.8 14.3
          17.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  0.7  1.7  2.9  4.3  6.0  8.0  9.9 12.1 14.3
          16.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  0.8  1.9  3.2  4.5  6.2  8.0  7.7 11.5 13.3
          15.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  0.8  1.7  2.9  4.1  5.5  7.1  8.8 10.4 12.1
          13.7  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  0.6  1.6  2.6  3.8  5.2  6.6  8.1  9.6 11.2
          12.8  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
LTTABLE        8                      LAUNCH TRIM TABLE (NORM. FORCE COEF.)
           0.0  1.0  2.1  3.4  4.8  6.2  7.6  9.0 10.8 12.5
          14.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  1.0  2.1  3.4  4.8  6.2  7.6  9.0 10.8 12.5
          14.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  0.9  2.0  3.4  4.9  6.4  8.2 10.2 13.2 15.6
          17.7  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  0.8  2.0  3.4  5.0  6.7  9.2 11.4 14.1 17.1
          20.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  0.8  2.1  3.6  5.1  7.1  9.5 11.7 14.2 16.8
          19.6  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  1.1  2.4  3.9  5.5  7.6  9.8 12.0 14.2 16.6
          18.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
```

```
           0.0  1.0  2.1  3.5  5.0  7.9  0.7 10.0 12.0 15.0
           17.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
           0.0  0.8  1.9  3.2  4.7  6.5  0.0  9.9 12.0 13.9
           16.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
MDTABLE     35                 MACH DRAG TABLE
           0.0  0.1  0.2  0.3  0.4  0.5  0.6
           0.65 0.7  0.75 0.8  0.9  1.0  1.05
           1.1  1.15 1.2  1.3  1.4  1.5  1.6
           1.7  1.8  1.9  2.0  2.1  2.2  2.3
           2.4  2.5  2.7  2.9  3.1  3.3  3.6
MTTABLE      8
           0.00      0.70      0.92      1.25
           1.62      2.00      3.00      3.50
POTABLE     35                 POWER OFF DRAG TABLE
           .385 .400 .420 .455 .500 .543 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .385 .400 .420 .455 .500 .543 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .385 .400 .420 .455 .500 .543 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .385 .400 .420 .455 .500 .543 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .385 .400 .420 .455 .500 .543 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .400 .412 .433 .470 .515 .560 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .415 .430 .453 .486 .535 .580 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .425 .440 .465 .500 .545 .593 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .435 .450 .475 .510 .557 .600 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .445 .464 .490 .527 .573 .637 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .465 .485 .507 .555 .600 .670 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .550 .580 .603 .640 .685 .745 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .670 .680 .700 .740 .780 .830 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .718 .730 .742 .780 .820 .860 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .740 .747 .770 .803 .843 .886 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .737 .746 .760 .802 .842 .885 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .722 .735 .756 .787 .830 .870 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .692 .705 .725 .755 .792 .835 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .660 .675 .692 .722 .757 .800 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .630 .645 .662 .687 .725 .765 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
```

```
           .605 .620 .635 .660 .695 .730 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .585 .596 .613 .635 .670 .703 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .563 .575 .592 .615 .645 .676 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .545 .560 .576 .597 .625 .655 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .530 .545 .562 .580 .610 .635 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .520 .530 .550 .570 .600 .620 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .510 .520 .536 .556 .580 .605 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .500 .510 .526 .546 .570 .593 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .491 .503 .517 .537 .560 .582 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .485 .495 .508 .528 .550 .572 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .473 .482 .495 .515 .532 .555 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .463 .473 .485 .504 .520 .540 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .455 .464 .475 .495 .510 .530 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .448 .455 .467 .485 .500 .520 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .440 .445 .457 .475 .490 .507 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
SDTABLE     35                 SUSTAIN DRAG TABLE
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
           .0   .0   .0   .0   .0   .0   .0   .0   .0   .0
           .700 .620 .570 .540 .433 .245 .0   .0   .0   .0
```

```
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .700 .620 .570 .540 .433 .245 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .700 .620 .570 .540 .433 .245 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .700 .620 .570 .540 .433 .245 .0    .0    .0    .0
      .0   .C   .0   .0   .0   .0   .0    .0    .0    .0
      .700 .620 .570 .540 .433 .245 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .700 .620 .570 .540 .433 .245 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .700 .620 .570 .540 .433 .245 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .700 .620 .570 .540 .433 .245 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .662 .620 .570 .540 .433 .245 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .625 .590 .556 .525 .435 .280 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .597 .560 .537 .510 .438 .305 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .575 .550 .522 .500 .440 .327 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .554 .530 .510 .490 .442 .345 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .537 .520 .498 .483 .443 .360 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .520 .510 .490 .480 .440 .370 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .510 .495 .480 .470 .445 .378 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .498 .483 .474 .465 .445 .387 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .488 .480 .467 .460 .445 .393 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .478 .473 .464 .456 .444 .397 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .466 .460 .456 .450 .443 .405 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .456 .450 .450 .442 .437 .414 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .447 .440 .440 .437 .435 .420 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .442 .440 .437 .435 .435 .422 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
      .437 .435 .434 .434 .434 .423 .0    .0    .0    .0
      .0   .0   .0   .0   .0   .0   .0    .0    .0    .0
TAPLEK  7                  FIRE CONTROL TABLE
     -562140.0       -202819.0        -340000.0
        -146.66         -890.6           -437.9
     1083332.0      -5616155.0          -4370.0
         -73.33         -445.3          -218.95
         733.33        10272.3          -6266.3
    -1330000.0     102000000.0       34100000.0

     1466.6         20544.6       -12532.6
TH          5              TH VALUES FOR MIN. HOMING OPTION
  0.0    3.0   12500.0    7718.0   0.04335
```

DISTRIBUTION

Commanding Officer
U.S. Air Force Armanent Laboratory (AFATL/DL MA)
Eglin Air Force Base, FL 32542
ATTN: F. Stevens
Technical Library (2)

Applied Physics Laboratory
The Johns Hopkins University
8621 Georgia Avenue
Silver Spring, MD 20910
ATTN: P. Voss
Technical Library (2)

Director
Advanced Research Projects Agency
Department of Defense
Washington, DC 20305
ATTN: Technical Library (2)

Director
Defense Research and Engineering
Department of Defense
Washington, DC 20305
ATTN: Technical Library (2)

Commander
George C. Marshal Flight Center
Huntsville, AL 35804
ATTN: Technical Library (2)

NASA Goddard Space Center
Greenbelt, MD 20771
ATTN: Technical Library (2)

NASA Lewis Research Center
Cleveland, OH 44101
ATTN: Technical Library (2)

NASA
Washington, DC 20546
ATTN: Technical Library (2)

Chief of Naval Research
Department of the Navy
Washington, DC 20360
ATTN: Technical Library (2)

Superintendent
U.S. Naval Academy
Annapolis, MD 21402
ATTN: Head, Weapons Department
Head, Science Department
Technical Library (2)

Superintendent
U.S. Naval Postgraduate School
Monterey, CA 95076
ATTN: Head, Mechanical Engineering Department
Head, Department of Aeronautics
Technical Library (2)

Officer in Charge
U.S. Naval Scientific and Technical Intelligence Center
U.S. Naval Observatory
Washington, DC 20360
ATTN: Technical Library (2)

Chief of Naval Research
Arlington, VA 22217
ATTN: Mr. Dave Seigel
Technical Library (2)

Chief of Naval Operations
Washington, DC 20350
ATTN: OP-098
Technical Library (2)

Commander
Naval Air Development Center
Warminister, PA 18974
ATTN: Technical Library (2)

Commander
Naval Air Engineering Center
Lakehurst, NJ 19112
Aeronautical Structures Department
ATTN: Aeronautical Structures Department
Technical Library (2)

Commander
Naval Air Systems Command
Washington, DC 20360
ATTN: AIR-320, Mr. Bill Volz
Technical Library (2)

Commander
Naval Sea Systems Command
Washington, DC 20360
ATTN: SEA-03, Mr. Lionel Pasiuk
Technical Library (2)

Commander
Naval Material Command
Washington, DC 20360
ATTN: MAT-032, Mr. Sid Jacobson
Technical Library (2)

Commander
Naval Weapons Center
China Lake, CA 93555
ATTN: Code 4063, Mr. Ray Van Aken
Code 4063, Mr. R. E. Meeker
Technical Library

Commander
Pacific Missile Test Center
Point Mugu, CA 93041
ATTN: Technical Library (2)

Commanding Officer
Naval Ordnance Station
Indian Head, MD 20640
ATTN: Technical Library (2)

Commandant of the Marine Corps
Headquarters, Marine Corps
Washington, CD 20380
ATTN: Technical Library (2)

Commander
Ballistic Research Laboratory
Aberdeen Proving Ground, MD 21005
ATTN: Technical Library (2)

Commander
Department of the Army
U.S. Army Armament Research and Development Command
Dover, NJ 07801
ATTN: Technical Library (2)

Commander
U.S. Army Missile Command
Redstone Arsenal, AL 35809
ATTN: Mr. Ray Deep (DRSMI)
Mr. D. J. Spring (DRSMI)
Technical Library (2)

Commander
U.S. Army Material Development and Readiness
  Command (AMCRD-TP)
50001 Eisenhower Avenue
Alexandria, VA 22304
ATTN: Technical Library (2)

Office of Chief of Research and Development
Washington, DC 20310
ATTN: Technical Library (2)

Commander
Army Chemical Center
Edgewood, MD 21040
ATTN: Technical Library (2)

NASA Ames Research Center
Moffett Field, CA 94035
ATTN: Technical Library (2)

Defense Documentation Center
Cameron Station
Alexandria, VA 22314 (12)

Library of Congress
Washington, DC 20390
ATTN: Gift and Exchange Division (4)

Defense Printing Service
Washington Navy Yard
Wasington, DC 20374

Local:

K20
K21 (10)
K70
K72 (10)
K81 (Mr. J. Holmes)
X210